विज्ञान

कक्षा 9 के लिए पाठ्यपुस्तक

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डी. बालासुब्रमणियन
जी.आर. भट
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सी. एन. राव अध्यक्ष, प्रकाशन विभाग

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दिनेश सक्सेना **संपादक**	सुरेन्द्र कान्त शर्मा **उत्पादन अधिकारी**
शर्मा दत्त **सहायक संपादक**	टी०टी० श्रीनिवासन **सहायक उत्पादन अधिकारी**
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आवरण : शांतो दत्त

मूल्य : रू. 6.00

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विषय सूची

गांधी जी का जन्तर

तुम्हें एक जन्तर देता हूं। जब भी तुम्हें सन्देह हो या तुम्हारा अहम् तुम पर हावी होने लगे, तो यह कसौटी आजमाओ:

जो सबसे गरीब और कमजोर आदमी तुमने देखा हो, उसकी शकल याद करो और अपने दिल से पूछो कि जो कदम उठाने का तुम विचार कर रहे हो, वह उस आदमी के लिए कितना उपयोगी होगा। क्या उससे उसे कुछ लाभ पहुंचेगा? क्या उससे वह अपने ही जीवन और भाग्य पर कुछ काबू रख सकेगा? यानि क्या उससे उन करोड़ों लोगों को स्वराज्य मिल सकेगा जिनके पेट भूखे हैं और आत्मा अतृप्त है?

तब तुम देखोगे कि तुम्हारा सन्देह मिट रहा है और अहम् समाप्त होता जा रहा है।

अध्याय 1

जीवन पद्धति : वास स्थान—रहने का स्थान तथा जीव

भूमिका

अपने आस पास के विविध सजीवों को देखें। ये सजीव जिनमें वृक्ष जैसे पीपल, आम, नीम, नारियल, अथवा यूकेलिप्टस, पौधे जैसे गुलाब, चमेली, विसर्पी लता, क्रोटॉन और केला, चावल, गेहूं अथवा मक्का, झाड़ियां जैसे स्कूल के चारों ओर मेढ़, कीकर, जानवर जैसे कुत्ता, भैंस, बिल्ली, हाथी अथवा ऊंट, पक्षी जैसे कोवा, तोता, चील, मोर, फाख्ता अथवा कबूतर, कीट जैसे मक्खी, मकड़ी, चींटी, दीमक, खटमल आदि हो सकते हैं। आप देखेंगे ये सजीव कितने भिन्न हैं फिर भी वे सब एक ही क्षेत्र में रहते हैं तथा फलते फूलते हैं। जिस स्थान पर वे रहते हैं वह उनके अनुकूल होना चाहिए, यदि ऐसा नहीं होता तो वे वहां नहीं रह सकते। अब आप विस्तारं से वास-स्थानों तथा वे अपने निवासियों की कैसे सहायता करते हैं, के विषय में पढ़ेंगे। आप यह भी देखेंगे कि जीव स्वयं को अपने वातावरण के अनुकूल कैसे बनाते हैं। कभी-कभी जन्तु भी कुछ समय के लिए वातावरण के लक्षणों को बदल देते हैं। जन्तुओं तथा वास-स्थानों की इस पारस्परिक क्रिया के अध्ययन से हम अपने विशाल वातावरण—पृथ्वी अथवा जीव मण्डल के विषय में महत्वपूर्ण जानकारी प्राप्त कर सकते हैं।

15.1 वास-स्थान

जीवों के लिए वास-स्थान ऐसा होना चाहिए जो जीव को जीवित रहने, जनन करने तथा फलने फूलने के लिए भोजन, आश्रय तथा अनुकूल जलवायु प्रदान कर सके। जीवों के लिए ऐसा **वास-स्थान** अनुकूल है। आवास शब्द का अर्थ है रहने का स्थान। जीवों का आवास किसी प्रदेश के संपूर्ण वातावरण का एक भाग है। उदाहरण के लिए बन्दर और लंगूर के रहने का आवास दक्षिण भारत, बर्मा, थाईलैंड, श्रीलंका, मलाया तथा सिंगापुर के वन हैं। इसका अर्थ केवल वन से अथवा किसी भी वन से नहीं है बल्कि इसका अर्थ इन उष्णकटिबंधीय देशों के वनों के वातावरण इनकी जलवायु, मौसम तथा यहां पर पाये जाने वाले पेड़ पौधों, जन्तुओं आदि से है।

आवास के भौतिक तथा जैविक दो घटक होते

हैं। भौतिक घटक में भौगोलिक अवस्थाएं जैसे ताप, वर्षा मौसम, जलवायु तथा पानी हैं। जैविक घटक का अर्थ उन सजीवों से है जो उस आवास में रहते हैं। उदाहरण के लिए चीते के आवास में कुछ जैविक घटक जैसे छोटे जानवर होने चाहिए जिनका शिकार चीता करके खा सके। चीते के आवास में छायादार पेड़ तथा झाड़ियां भी होनी चाहिए जिनमें वह शिकार करने के लिए छुप सके। हिमालय के वनों तथा सुन्दरवनों में हिमालयन बाघ तथा बंगाल बाघ पाए जाते हैं, ये वन बाघ को जैविक आवश्यकताएँ प्रदान करते हैं (चित्र 15.1)। अन्य कोई भी वन जैसे उत्तर-पश्चिमी अमेरिका के पथरीले पहाड़ बाघ के वास स्थान नहीं हो सकते। भौतिक तथा जैविक लक्षण जीव के अनुकूल होने चाहिए अन्यथा जीव प्रजनन नहीं कर सकता और न ही फल फूल सकता है।

चित्र 15.1 बंगाल टाइगर (हैदराबाद के श्री थिरूमालेश्वर के सौजन्य से)।

15.2 सूक्ष्मावास

एक ही आवास में भी भिन्नता होती है। आइए हम भूमि का उदाहरण लें। भूमि के किसी एक क्षेत्र की जलवायु, दूसरे क्षेत्र की जलवायु से भिन्न हो सकती है। भारत में ही लद्दाख की जलवायु और वातावरण, केरल की जलवायु और वातावरण से बहुत भिन्न है। केला और नारियल जो केरल में अत्यधिक मात्रा में पैदा होते हैं, लद्दाख में बिल्कुल भी नहीं पाये जाते हैं। लद्दाख में इन पौधों को जलवायु, पानी, मिट्टी और पोषक तत्व इनकी आवश्यकतानुसार नहीं

मिल पाते हैं। यहां तक कि बड़े आवास में भी, जिसे स्थलीय आवास कहते हैं, ऐसे क्षेत्र होते हैं जो कुछ जीवों के लिए अनुकूल होते हैं जबकि दूसरे जीवों के लिए अनुकूल नहीं होते। किसी भी आवास में किसी भी क्षेत्र को सूक्ष्मावास कह सकते हैं जिसमें ऐसे विशेष गुण हों जो अन्य जीवों की अपेक्षा कुछ विशेष जीवों के लिए अनुकूल हों।

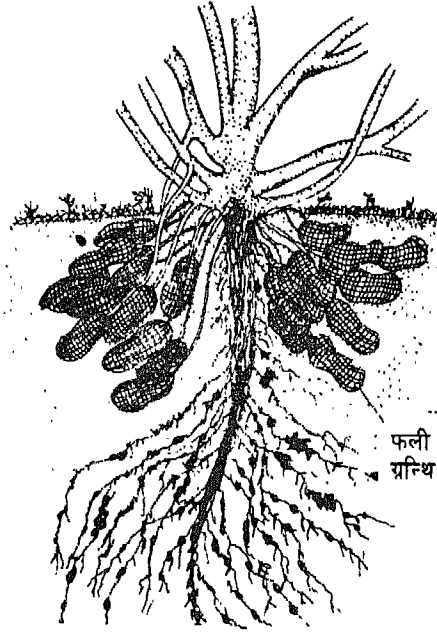
दूसरा उदाहरण हम चूहों का ले सकते हैं। चूहे विभिन्न परिवार या वर्ग के होते हैं। इनमें से कुछ *स्थलीय* होते हैं, जैसे खेतों में पाये जाने वाले सामान्य चूहे। ये चूहे उत्तर प्रदेश, मध्य प्रदेश, बिहार, आन्ध्र प्रदेश आदि के खेतों में रहना पसन्द करते हैं। परन्तु हम देखते हैं कि राजस्थान के मरुस्थल क्षेत्रों में पाए जाने वाले चूहों का व्यवहार और आदतें दूसरे चूहों से भिन्न होती हैं। इनका साइज छोटा होता है। ये भूमि में बिल बनाकर रहते हैं, बहुधा रात को बाहर निकलते हैं और इन्हें अधिक पानी की आवश्यकता भी नहीं होती है। इनके लिए उत्तर प्रदेश अथवा मध्यप्रदेश के मैदानी क्षेत्रों की अपेक्षा राजस्थान के मरुस्थल का सूक्ष्मावास अधिक उपयुक्त होता है।

आप पेड़ों तथा चट्टानों पर भी सूक्ष्मावास को देख सकते हैं। ऐसे भी जीव हैं जो पेड़ों की छाल तथा चट्टानों की दरारों में पाये जाते हैं। यह इन जीवों का सूक्ष्मावास है। सूक्ष्मावास का शब्द क्षेत्र के सम्बन्ध में उपयोग किया जाता है न कि आबादी के क्षेत्र पर।

15.3 परस्पर निर्भरता

प्रायः किसी आवास में दो स्पीशीज़ एक दूसरे की भलाई के लिए परस्पर निर्भर रहते हैं। प्रत्येक स्पीशीज़ अपनी आवश्यकताओं को पूरा करने के लिए दूसरे पर निर्भर होती है। आपने ऐसे छोटे पक्षियों को देखा होगा जो भैंस के ऊपर बैठते हैं। यह पक्षी जिसे एग्रेट कहते हैं हर समय भैंस के ऊपर सवारी करता है और भैंस की खाल तथा सींगों पर स्थित जूं, किलनी तथा अन्य कीटों को खाता है। इससे भैंस तथा एग्रेट पक्षी दोनों को लाभ होता है। भैंस कष्टकारी कीटों से छुटकारा पाती है और एग्रेट पक्षी को मुफ्त में भोजन मिल जाता है। कुछ अन्य पक्षी जैसे किलनी पक्षी भी राइनोसिरस (गैंडा) का वैसे ही सहभागी है जैसे एग्रेट भैंस का। अफ्रीका में ऑस्ट्रिच पक्षी जेब्रा और बारहसिंगा के झुण्डों के साथ रहते हैं। ये (ऑस्ट्रिच) इनकी रखवाली करते हैं और इसके बदले में इनसे भोजन प्राप्त करते हैं।

यहां तक कि पौधे और सूक्ष्मजीव भी एक दूसरे की भलाई के लिए सहभागी होते हैं। एक सूक्ष्मजीव, जिसे **राइजोबियम** कहते हैं, मटर, दालों तथा अन्य लैग्यूम के पौधों की जड़ों में रहता है और इन पौधों को वातावरण से नाइट्रोजन प्राप्त करने में सहायता करता है। इसके बदले में पौधे सूक्ष्मजीव को इसकी वृद्धि के लिए पोषक तत्व तथा भोजन देते हैं (चित्र 15.2)।

परजीवी उस वर्ग के जीव हैं जो अपने भोजन, वृद्धि तथा गुणन के लिए दूसरे जीवों पर निर्भर होते हैं। परपोषी जीव को इसके बदले में कुछ नहीं मिलता है। यह केवल परजीवों की वृद्धि के लिए एक संवहन की तरह कार्य करता है, इस प्रक्रिया में परपोषी को बहुत हानि होती है। मनुष्य में मलेरिया फैलाने वाला रोगाणु एक परजीवी है। यह परजीवी मच्छर में रहता है और जब मच्छर किसी मनुष्य को काटता है तब ये

चित्र 15.2 लैग्यूम के पौधे की जड़ तथा राइजोबियम में सहजीवी संबंध।

परजीवी मनुष्य के रक्त में चला जाता है जहां इसकी वृद्धि होती है, जिसके परिणाम स्वरूप मनुष्य को मलेरिया का बुखार हो जाता है। फीताकृमि अन्य परजीवी है जो पशु या सूअर से मनुष्य के शरीर में प्रवेश करता है और मनुष्य की आंतों में वृद्धि करके यह लारवा से कृमि में बदल जाता है।

किसी वास-स्थान में, जलवायु तथा जैविक घटकों में पारस्परिक सम्बन्ध होता है। अगर किसी क्षेत्र में अधिक वृक्ष होंगे तो वह क्षेत्र ठण्डा होगा, वहां की मिट्टी अच्छी होगी और इसमें अधिक जीव रह सकेंगे। वृक्ष और पर्ण समूह आवास में, ताप तथा आर्द्रता को प्रभावित करते हैं। हम इनके विषय में विस्तृत वर्णन बाद में पढ़ेंगे।

15.4 भूमि, पानी तथा हवा वास स्थान के रूप में

मछली पानी में रहती है, आदमी भूमि पर रहता है तथा चील हवा में उड़ती है। आवास के प्रकार जीवों के अनुसार भिन्न-भिन्न होते हैं। जो जीव पानी में रहते तथा प्रजनन करते हैं उन्हें जलीय (aquatic) कहते हैं (लेटिन में अक्वा का अर्थ है पानी)। जो जीव जमीन पर रहते हैं तथा वहां पर प्रजनन करते हैं उन्हें स्थलीय (Terrestrial) कहते हैं (लेटिन भाषा में टेरा शब्द का अर्थ भूमि है)। जो जीव अपनी क्रियाएं आकाश में करते हैं उन्हें वास्तव में आकाशी या वृक्षीय (arboreal) कहते हैं। "अर्बोर" शब्द का अर्थ है पेड़ या शाखाएं और यह उचित भी है क्योंकि पक्षी अपने घोंसले पेड़ों पर बनाते हैं और वहीं विश्राम करते हैं। इसके अतिरिक्त पक्षी अपनी अधिकतर क्रियाएं हवा में या उड़ते समय ही करते हैं। चील तथा अबाबील इसके दो अच्छे उदाहरण हैं।

जीवों का वर्गीकरण जैसे जलीय, स्थलीय तथा आकाशी हमेशा लागू नहीं होता। आप मेंढक या मगरमच्छ का वर्गीकरण कैसे करेंगे? ये किसी नदी के तट पर रहना पसन्द करते हैं जिससे ये जल तथा स्थल दोनों को आवास के रूप में उपयोग कर सकें। ऐसे जीवों को **जलस्थलचर** (amphibian) कहते हैं। ग्रीक भाषा में एम्फी का अर्थ दोनों और बाओस का अर्थ जीवन है।

एक ही आवास में कई प्रकार के जीव आपस में मिल कर रहते हैं। इसका अर्थ यह है कि आवास अपने निवासियों को भोजन तथा जलवायु दोनों देता है जिससे वे अच्छी तरह से वृद्धि तथा प्रजनन कर सकें। उष्णकटिबंधीय वन चूहे, खरगोश, हिरण, भालू, शेर, बन्दर, वन पक्षी, बांस तथा साल के पेड़, तरह तरह की विसर्पी

लताओं तथा झाड़ियों, सांप, मेंढक विभिन्न प्रकार के कीट, मछलियाँ जैसे मुरेल, रोह, ट्राउट, कार्प तथा सैंकड़ों अन्य जीवों के आवास हैं। अधिकाँश स्पीशीज की इस आवास में भोजन तथा अन्य आवश्यकताओं की पूर्ति हो जाती है। इस कार्य के लिए पूरा तंत्र संतुलित होता है।

यह संतुलन किसी स्पीशीज की आबादी पर भी लागू होता है। यदि कीटों की जनसंख्या अधिक हो जाए तो मेंढक, सांप, पक्षी कीटों को खाकर उनकी आबादी कम कर देंगे। ये परभक्षी अपने शिकार की आबादी कम करते हैं। इन परभक्षियों की भी संख्या कम हो जाती है जब इनके परभक्षी इन्हें खाते हैं। जनसंख्या नियंत्रण के लिए परभक्षी-शिकार की यह श्रृंखला कब तक चलती रहेगी? अगर किसी वन में बाघ की संख्या अधिक है और हिरण या अन्य जानवरों की कम, तो बाघ की संख्या अपने आप ही कम होती जाएगी। बाघों को इस प्रकार से भोजन प्राप्त न होने के कारण उनकी आबादी नष्ट होती जाएगी। जैसे-जैसे बाघों की संख्या कम होगी वैसे-वैसे ही हिरण कम मरेंगे और हिरणों की संख्या धीरे-धीरे बढ़ती जाएगी। आपने देखा कि **किसी वास-स्थान में रहने वाले विभिन्न प्रकार के जीव किस प्रकार जैविक जनसंख्या में पारस्परिक संतुलन बनाये रखते हैं।**

दूसरा उदाहरण जलीय पौधे का लें जो किसी सरोवर या झील में बहुत तेजी से वृद्धि करता है। इस पौधों को जलकुम्भी (वाटर हायासिंथ) कहते हैं। इन पौधों की वृद्धि इतनी शीघ्रता से होती है कि ये पौधे तालाबों तथा झीलों के बहुत से पोषक तत्वों का उपयोग कर लेते हैं। दूसरे जीव पोषक तत्वों की कमी के कारण नष्ट हो जाते हैं तथा सारा तालाब अथवा झील जलकुम्भी से ढक जाती है। तब झील में अन्य जीव जीवित नहीं रह पाते। ऐसी स्थिति हैदराबाद में स्थित सुन्दर झील हुसैन सागर में कुछ साल पहले हुई थी। तब जलकुम्भी को मशीनों द्वारा तथा जीवीय विधियों से हटाया गया था जिससे झील को फिर से विभिन्न जीवों के आवास के लिए उपयुक्त बनाया गया।

क्रियाकलाप—1

अपने आस पास के परिवेश में पाए जाने वाले समस्त जीवों के नाम लिखो। उनका जलीय, स्थलीय, आकाशी तथा जलस्थलचर आदि के अनुसार वर्गीकरण करो। क्या आपने वहां जलीय पौधे देखें हैं? आप कितने प्रकार के जलस्थलचर जीवों की सूची बना सकते हैं।

15.5 अनुकूलन

जीव ऐसे आवास में रहते हैं जो उनकी आवश्यकताओं को पूरा कर सके। ऐसे जीव जो अपने आवास से सहयोग करते हैं वे दूसरे जीवों की अपेक्षा वहां सफलतापूर्वक जीवित रहते हैं और प्रजनन करते हैं। **मरुस्थली चूहा इसका एक** उदाहरण है। ये चूहे मैदानी चूहे की अपेक्षा वहाँ के वातावरण से अच्छी तरह अनुकूलित हो जाते हैं। **ऐसे ही ऊंट भी भैंस की अपेक्षा मरुस्थल में अच्छी प्रकार रहने के अनुकूल होता है। तो हम यह कह सकते हैं कि मरुस्थली चूहे तथा ऊंट ने अपने** आप को उस आवास या वातावरण के अनुकूल बना लिया है।

15.6 जलीय वास-स्थान तथा अनुकूलन

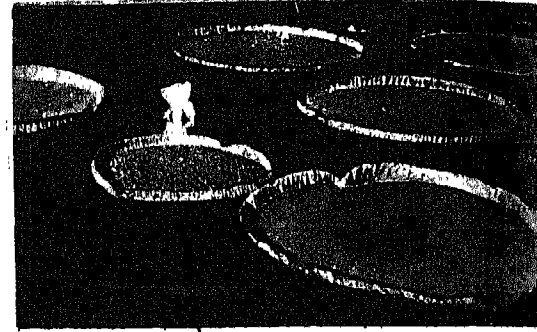
आओ, जलीय आवास जैसे पोखर, तालाब, झील,

झरने, नदियां, नाले आदि के विषय में पढ़ें। जो जीव इन वास स्थानों में पाए जाते हैं उन्हें बहुत से भौतिक कारकों का सामना करना होता है। ये भौतिक कारक हैं ऑक्सीजन तथा प्रकाश की उपलब्धता, दाब में परिवर्तन, गति में अवरोध, लवण की सांद्रता आदि।

आओ पोखरों, झीलों और झरनों में पाए जाने वाले पौधों को देखें। आपको कुछ पौधे जैसे हाइड्रिला, लेम्ना, जलकुम्भी तथा शैवाल पानी पर स्वतंत्र रूप से तैरते दिखाई देंगे। इनमें कुछ पौधे ऐसे भी हैं जिनकी जड़ें मिट्टी में होती हैं तथा उनके कुछ भाग जैसे पत्तियाँ और फूल पानी पर तैरते हैं। इसके कुछ उदाहरण हैं जैसे कमल या लिली।

क्रियाकलाप–2 से पता लगेगा कि पानी के अन्दर रहने वाले पौधे कैसे अनुकूलित होते हैं और वे वहां कैसे वृद्धि करते हैं। यहां पर पौधे का अनुकूलन उत्प्लावकता के लिए होगा जिससे पौधा क्षय होने से बच सकेगा। यदि आप अपना हाथ अथवा पैर काफी समय तक पानी में डुबोए रखें तो हाथ पैर पर सिकुड़न हो जाएगी। लेकिन कमल अथवा लिली के पौधों में ऐसी सिकुड़न नहीं होती।

क्रियाकलाप–2

आपको हाइड्रिला के पौधे, प्राकृतिक स्पंज, जलकुम्भी या लिली के पौधों की आवश्यकता होगी। लिली या जलकुम्भी के पौधों के वृंत्त (stalk) को देखें। आप इनके वृंत्त को काटकर तथा पकाकर खा सकते हैं। इन पौधों के वृंत में बहुत से छिद्र तथा खोखलापन होता है जो इन्हें पानी में सीधा रखने में सहायता करता है। जल लिली के बड़े आकार के पत्तों को देखें (चित्र 15.3)। इसका आकार वृत्त या बड़े डिस्क के समान होता है जिससे यह पानी में तैरता रहता है। उत्प्लावकता की अनुकूलता के लिए इसे पानी की सतह पर होना चाहिए जिससे कि यह प्रकाश संश्लेषण कर सके। पानी में कभी भी इसकी पत्ती सिकुड़ती या नष्ट नहीं होती है। पत्ते की सतह पर एक तेलीय परत होती है। यह पत्ते को जलअवरोधी बना देती है और उसे पानी में गीला होने या क्षय होने से बचाती है। ये पत्ते मछली के शल्क के समान होते हैं जो मछली की त्वचा को जलसह बनाते हैं।

चित्र 15.3 वाटर लिली। तैरती पत्तियों सहित एक जलीय पौधा। इसका तना मुख्यतः खोखला होता है और पत्तियाँ चौड़ी गोलाकार होती हैं और सरलता से पानी में गीली नहीं होती।

जलीय जीव अपना खनिज लवण पानी से प्राप्त करते हैं। इन आवासों में लवण की सांद्रता भिन्न-भिन्न होती है। इसीलिए स्वच्छ जल में मिलने वाली मछलियाँ समुद में जीवित नहीं रह सकती। सामान्य नीली हरी शैवाल, **स्पाइरोगाइरा** तथा **यूलोथ्रिक्स** समुद्र की अपेक्षा तालाबों में पाई जाती है क्योंकि समुद्र में लवण सान्द्रता अधिक होती है।

क्रियाकलाप—3

एक स्लाइड पर **स्पाइरोगाइरा** शैवाल के कुछ तन्तु लें। इस पर एक बूंद पानी की डालें और कवर स्लिप से ढककर इसे सूक्ष्मदर्शी में देखें। अब इस स्लाइड पर लवण का सान्द्र घोल डालें और तन्तुओं की कोशिकाओं में हुए परिवर्तनों को देखें। अब फिर स्लाइड पर पानी डालें और परिवर्तनों का अवलोकन करें। आप इन परिवर्तनों का सम्बन्ध उस पानी में लवण की सान्द्रता, जिसमें तन्तु रखा हुआ था, से लगा सकते हैं।

जलीय जीव की गति भी पानी से प्रभावित होती है। आप अपने हाथ पैरों को पानी की अपेक्षा हवा में आसानी से हिला डुला सकते हैं। जलीय जीवों के शरीर की रचना उनके संचलन के अनुकूल होती है। जलीय पौधा **वेलिसनेरिया** नहरों के बहते हुए पानी में पाया जाता है। इसके पत्ते लम्बे तथा सकरे होते हैं। पत्तों की ऐसी आकृति बहते हुए पानी में बाधक नहीं बनती। इसी प्रकार लिली जैसे जलीय पौधे पानी में कम दाब का अनुभव करते हैं क्योंकि इनकी जड़ें पोखर के स्थिर जल में स्थित रहती हैं।

मछली के शरीर की रचना को देखें। इसके शरीर पर शल्क के महत्व को हम पहले ही बता चुके हैं। कुछ मछलियों के पार्श्व में गिल होते हैं। गिल शरीर में वे अंग हैं जो पानी में घुलित ऑक्सीजन को लेने में सहायता करते हैं। गिल की फैली हुई सतह पानी की सतह से पर्याप्त संपर्क प्रदान करती है। ऑक्सीजन प्राप्त करने के लिए यह अनुकूल होती है। कुछ मछलियों तथा जलीय कीटों के शरीर में हवा के बुलबुले पाए जाते हैं। ये बुलबुले उत्प्लावकता में सहायता करते हैं। जलीय जीव में शरीर का भीतरी दाब पानी के बाहरी दाब को संतुलित करता है। इस प्रकार का अनुकूलन बदलते हुए दाब का सामना करता है।

अब मछली की आकृति देखो। पार्श्व में लगे पंख गति में तथा दिशा में परिवर्तन में सहायता करते हैं और इसकी पूंछ इसके लिए गति नियंत्रक (rudder) की तरह कार्य करती है। मछली का शरीर तैरने के लिए अनुकूल होता है। यदि आप तैराक हों तो सोचें कि जब आप पानी में कूद रहें हों तो आप शरीर को किस स्थिति में रखेंगे। अब आप इस स्थिति की तुलना मछली की आकृति से करें। ऐसी आकृति को धारा रेखित कहते हैं। ऐसी आकृति होने से गति में अवरोध बहुत कम होता है। अब हम व्हेल की आकृति का उसके जलीय आवास से सम्बन्ध देख सकते हैं।

अब हम देख सकते हैं कि मनुष्य आकाश में उड़ने की अपेक्षा पानी में तैरने के लिए अधिक उपयुक्त हैं। इटली के एक वैज्ञानिक तथा आविष्कारक लिओनार्डो द विन्ची ने ऐसे पंख बनाने का प्रयत्न किया था जिन्हें मनुष्य के शरीर से जोड़ कर उड़ा जा सके। अगले अध्याय में पक्षियों के चित्र में देखें कि उड़ते हुए पक्षियों के शरीर की रचना कैसी है। वे उड़ने के लिए अच्छी तरह से अनुकूलित होते हैं। अब आप चूजों अथवा शुतुरमुर्ग को देखें। ये दोनों वास्तव में स्थलीय हैं। पक्षी उड़ने के लिए कैसे अनुकूलित होते हैं इसका वर्णन अगले अध्याय में किया गया है।

15.7 स्थलीय वासस्थान तथा अनुकूलन

स्थलीय वासस्थान में विभिन्न भौतिक घटक होते हैं जैसे मिट्टी, ताप, नमी, आदि। स्थल

विच्छिन्न वासस्थान है क्योंकि इसके बीच में कहीं-कहीं नदियाँ, नाले, समुद्र तथा पहाड़ आ जाते हैं। स्थलीय जीवों को जलीय आवास की अपेक्षा पर्याप्त मात्रा में प्रकाश तथा ऑक्सीजन प्राप्त होता है। पानी जीवों को प्रभावित करने वाला एक प्रमुख कारक है। ताप भी स्थलीय जीवों को प्रभावित करता है। प्रकाश की उपलब्धता के कारण ताप भी बदलता रहता है। इन दोनों कारकों के आधार पर स्थल के विभिन्न क्षेत्र हैं जैसे शुष्क और गर्म (मरुस्थल) तथा नम और ठंडा (पहाड़ी तथा मैदानी)। इन क्षेत्रों को क्रमशः मरुर्दुभिदी तथा समोर्दभिदीय आवास कहते हैं।

भैंस तथा गाय

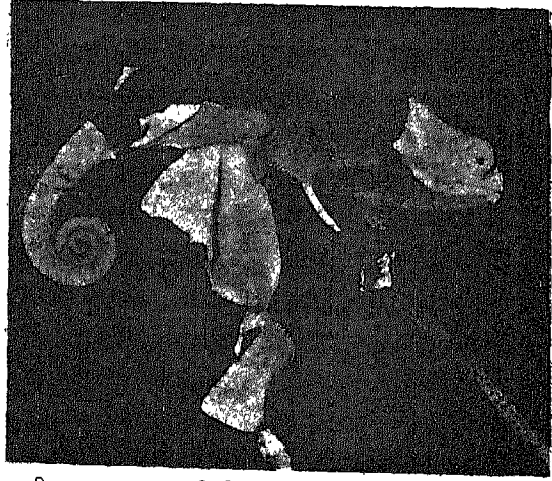
भैस तथा गाय दोनों हमें दूध देती हैं। भैंस का दूध गाय के दूध की अपेक्षा अधिक गाढ़ा होता है तथा वसायुक्त होता है। इसलिए दूधिया या प्राइवेट डेरी के किसान गाय की अपेक्षा भैंस रखना अधिक पसन्द करते हैं। भैंस भारत के सभी स्थानों पर पाली जाती है जैसे राजस्थान, हरियाणा, पंजाब, तमिलनाड, केरल, मेघालय तथा नागालैंड। भैंस का सूक्ष्मावास क्या है?

भारत में जो भैंस मिलती हैं उन्हें वास्तव में जलीय भैंस कहते हैं और इनका सूक्ष्मावाम है दलदली स्थान जैसे बंगाल, आंध्र प्रदेश, तमिलनाडु, अथवा केरल के नदी के तट। यह मिट्टी और पानी में रेलना अधिक पसन्द करती हैं क्योंकि वे भारत की गर्मी सहन नहीं कर पाती हैं। इनकी काली त्वचा पर बहुत कम बाल होते हैं। अगर इनकी त्वचा केवल सफेद होती तो इनको गर्मी कम लगती। इसमें कोई आश्चर्य की बात नहीं है कि ये अधिकतर समय पानी में आराम करती हैं, इसलिए इन्हें जलीय भैंस कहते हैं। शुष्क स्थानों पर रहने वाली भैंसों को न केवल अधिक आराम, पानी और छाया की आवश्यकता होती है बल्कि वे गर्मी में दूध भी पतला देती हैं। तो क्या राजस्थान की डेरी के किसानों को भैंस रखकर लाभ होता है? अब गाय की तरफ देखें। क्या गाय को आपने भैंस की तरह गंदे पानी में रेलते हुए देखा है? क्या यह भैंस से हल्के रंग की नहीं होती है? क्या यह डेरी के किसानों के लिए अच्छा नहीं होगा यदि वे ऐसे पशुओं को चुनें तथा उनका उपयोग करें जो वातावरण में अच्छी तरह रह सकते हों। किसी भिन्न वासस्थान में भैंसे पतला दूध देती हैं और इनकी अधिक देखभाल करनी पड़ती है।

15.8 पौधों तथा जन्तुओं में अनुकूलन के उदाहरण

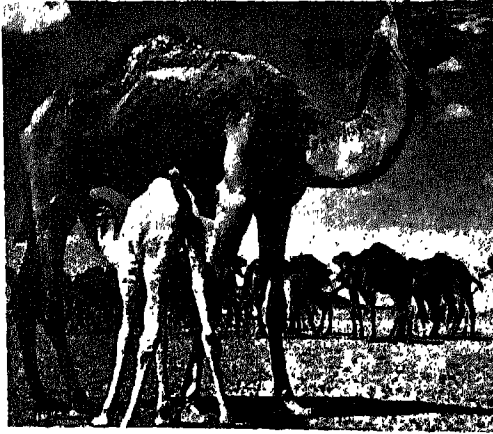
भारत तथा दक्षिण पूर्व एशिया के उष्णकटिबंधीय वन के पौधे तथा जन्तु वहाँ के वातावरण से अच्छी तरह अनुकूलित होते हैं। आर्किड पौधे इन्हीं वनों में प्रमुख रूप से पाए जाते हैं।

उन्होंने अपने को यहां के बदलते हुए ताप तथा आर्द्रता के अनुकूल कर लिया है। इन पौधों के तने पानी संचय का कार्य करते हैं। इनके पत्ते ऐसे विशेष प्रकार के होते हैं जो शुष्कता को बाहर रख कर पानी को संचित करते हैं। इनकी परिभ्रमी जड़ होती है जो पानी की खोज में रहती है और बरसात के मौसम में जितना अधिक से अधिक हो सके पानी का संचय कर लेती है।

गिरगिट (तमिल में प्रटचौड़ी, तेलगू में उसरवाली तथा हिन्दी में गिरगिट) एक सरीसृप है जो छिपकली तथा इगुआना के जैसा है (चित्र 15.4a)। यह कीटों को पकड़ने के लिए विशेष प्रकार से अनुकूलित होता है। यह देखने में आकर्षक नहीं होता है, इसकी टांगे पतली होती हैं तथा एक लम्बी पूंछ पांचवें पाद के रूप में होती है। इसकी टांगों की दो अंगुलियां शेष तीन अंगुलियों से विपरीत दिशा में होती हैं। इससे गिरगिट में पकड़ने की शक्ति अधिक हो जाती है (आपने तानाजी के विषय में सुना होगा। वे शिवाजी की सेना में जनरल थे। उन्होंने गिरगिट की जाति वाले घोरपाड़ का उपयोग रायगढ़ किले की दीवार पर चढ़ने के लिए किया था। उन्होंने इस जन्तु को ऊपर फेंका। यह जन्तु दीवार से चिपक गया और वह फिर जन्तु से बन्धी रस्सी की सहायता से किले की दीवार पर चढ़ गये)। गिरगिट की आंखें भी बहुत विचित्र होती हैं। वह अपनी आंखों को किसी भी दिशा में घुमा सकता है और इनकी आंखें एक ही समय में अलग-अलग कार्य कर सकती हैं। गिरगिट एक ही समय में अपनी दायीं आंख से आगे की ओर और अपनी बाईं आंख से पीछे की ओर देख सकता है। इसकी जीभ भी विचित्र है। इसकी जीभ जो प्रायः एक

चित्र 15.4 (a) अफ्रीकी गिरगिट : अपनी त्वचा उतार रहा है।

फुट लम्बी होती है वह टेप की तरह मुड़ जाती है और यह इसको अपने मुंह में रखता है। गिरगिट जब अपने शिकार को देखता है तो अपनी जीभ को बड़ी फुर्ती से बाहर निकालता है (चित्र 15.4b)। अपनी त्वचा का रंग बदलना गिरगिट

चित्र 15.4 (b) गिरगिट अपनी लम्बी जीभ की सहायता से शिकार पकड़ रहा है।

का सबसे महत्वपूर्ण लक्षण है। जब यह पेड़ की टहनियों पर होता है तब इसकी त्वचा का रंग हरा हो जाता है और जब चट्टानों पर होता है तब इसकी त्वचा भूरे रंग की हो जाती है। मान लो कुछ दूरी पर एक कीट पत्ते पर बैठा है। गिरगिट धीरे-धीरे वहां आता है और अपनी त्वचा का रंग पत्ते जैसा कर लेता है। बेचारे कीट को पता भी नहीं चलता कि उसका परभक्षी उसके समीप ही है। गिरगिट अपने शिकार के बहुत समीप आता हे और प्रकाश जैसे तीव्र गति से अपनी जीभ को कीट पर फैंक कर उसे पकड़ लेता है। इसके बाद उसी क्षण वह अपनी जीभ को मुँह में ले जाता है और अपनी आंखें बन्द करके आराम करता है। आपने कुछ ऐसे ही लक्षण सामान्य छिपकली में भी देखें होंगे। छिपकली गिरगिट की तरह अपनी आंखों को नहीं घुमा सकती है। इसके पैरों पर निर्वात गद्दियाँ होती हैं जिससे ये किसी वस्तु को अच्छी तरह से पकड़ सकती हैं। इस अनुकूलन से यह छत के ऊपर तथा नीचे आराम से घूम सकती है अथवा दीवार पर तेजी से चढ़ या उतर सकती हैं।

चित्र 15.5 भारतीय ऊँट।

ऊँट अनुकूलन का अन्य उत्तम उदाहरण है (चित्र 15.5)। यह मरुस्थल में बड़े आराम से रहता है जहां इसे रेत के टीलों से निकलना पड़ता है। मरूस्थल में पानी और भोजन की भी कमी होती है। ऊंट वास्तव में मरुस्थल का जहाज है। इसके पैरों को देखें। यह चलते समय अपने पैर का उपयोग करता है और इसके खुर बड़े तलवों से ढके होते हैं जिससे यह गर्म तथा फिसलने वाली रेत पर चल सकता है। यह एक दिन में 100 किलोमीटर तक चल सकता है और दस दिन तक लगातार बिना भोजन तथा पानी के रह सकता है। आवश्यकता होने पर यह रेत पर 20-25 किलोमीटर प्रति घण्टे की चाल से भाग सकता है। इसकी पीठ पर कूबड़ होता है। कूबड़ कुरचना नहीं है बल्कि वास्तव में इसमें भोजन एकत्र रहता है और वसा से भरा होता है। आप देख सकते हैं कि जब ऊंट भूखा होता है तो इसके कूबड़ का साइज कम हो जाता है और जब यह अपना पूरा भोजन कर लेता है तो कूबड़ फिर अपने वास्तविक आकार में आ जाता है। ऊंट का विशेष गुण यह है कि यह बिना पानी के दो सप्ताह तक रह सकता है। तो फिर यह अपनी पानी की आवश्यकता कैसे पूरी करता है?

क. जब यह पानी पीता है तब एक ही घूंट में 50 लीटर पानी पी जाता है अर्थात् तीन बाल्टी पानी एक लम्बी घूंट में।

ख. यह पानी किसी विशेष जगह या अंग में ही इकट्ठा नहीं होता बल्कि शरीर के सारे उत्तकों में समान रूप से वितरित हो जाता है

ग. यह अपने शरीर से बहुत कम पानी उत्सर्जित करता है। जब पानी की कमी होती है तो यह पूरे दिन में आधा लीटर मूत्र

ही करता है। यह मात्रा सामान्य स्थिति से 10-12 गुना कम है।

घ. इसके गोबर में भी गधे अथवा गाय के गोबर की अपेक्षा कम पानी होता है।

ङ. इसे पसीना भी बहुत कम आता है और इसकी साँस लेने की लय भी हमेशा धीमी होती है। यह हमेशा याद रखें जब यह लय अधिक होती है तब श्वसन में नमी भी अधिक होती है।

च. ऊंट की सबसे महत्वपूर्ण विशेषता यह है कि यह बाहर के वातावरण से अपने शरीर के ताप को सन्तुलित कर लेता है। इसलिए पसीना या किसी अन्य विधि से पानी की हानि कम होती है। हमें पसीना अधिक आता है इसलिए मरूस्थल में हमारे शरीर में पानी की कमी हो जाएगी क्योंकि हमारे शरीर का ताप 37° C (सेल्सियस) है जबकि बाहर का ताप 45° C (सेल्सियस) तक हो जाता है। ऊंट अपने शरीर का ताप 41° C (सेल्सियस) से 42° C (सेल्सियस) तक बढ़ा सकता है।

मरुस्थल में उगने वाले पौधों में भी अपने वातावरण के प्रति अनुकूलन होता है। इसका एक उत्तम उदाहरण है नागफनी। इसकी पत्तियाँ शल्कमय अथवा कांटेदार हो जाती है। इससे पत्ती की सतह से वाष्पोत्सर्जन नहीं हो पाता है। इन पौधों में रन्ध्र गर्त में होते हैं। इस कारण वाष्पोत्सर्जन की दर कम हो जाती है। पत्तियों तथा तनों की सतह पर एक मोटी परत होती है जिसे उपत्वचा (क्यूटिकल) कहते हैं।

कुछ मरुपौधों से पत्तियां झड़ जाती हैं जिसके कारण सतही क्षेत्रफल कम हो जाता है और पानी की हानि भी कम हो जाती है। यदि आप नागफनी को दबा कर देखें तो आपको यह स्पंजी तथा गूदेदार लगेगी। ये विशेषताएं पानी को संचित करने में सहायता करती हैं।

मरुदूमिदी पौधों में पानी की कमी से निपटने के लिए अन्य अनुकूलन यह है कि ये बीज या जड़ के रूप में प्रसुप्त अवस्था में रहते हैं। वर्षा आने पर यह पुनः अंकुरित हो जाते हैं।

मरुस्थल में पाए जाने वाले जन्तु भी ताप तथा पानी की कमी का सामना करने के लिए अपने आप को अनुकूलित करते हैं। मरुस्थली चूहे तथा सांप मिट्टी में सुरंग या बिल बना कर उनमें रहते हैं। गरम रेत के नीचे बने बिलों में नमी रहती है और वे ठंडे होते हैं। रात के समय जब रेत ठंडी हो जाती है तो ये अपने बिलों से बाहर निकल कर सक्रिय हो जाते हैं।

जीवों में अन्य पर्यावरण में भी अनुकूलन होता है। आप को पहले बताया जा चुका है कि भारत की भैंस वास्तव में कच्छ (दलदली) क्षेत्रों का पशु है। जब इसे बहुत अधिक गर्मी लगती है तब यह अपने पसीने से शरीर को ठंडा नहीं कर सकती क्योंकि इसमें स्वेद ग्रन्थियां दक्ष नहीं होती, इसलिए यह पानी तथा दलदल में रेलती है। राइनोसिरस तथा हिपोपोटेमस भी इसी प्रकार के अन्य उदाहरण हैं।

आपने पढ़ा है कि ऊंट अपने शरीर के ताप को किस प्रकार बाहरी गर्मी से समायोजित करता है। लेकिन मनुष्य वातावरण के अनुसार अपने शरीर का ताप नहीं बदल सकता। लेकिन कुछ बाहयष्मी जन्तु तथा कीट अपने आस-पास के वातावरण से गर्मी (ऊष्मा) लेकर अपने शरीर के ताप को बढ़ा सकते हैं। ऐसे जन्तुओं को

असमतापी कहते हैं और वे गर्मियों अथवा धूप वाले दिनों में अधिक सक्रिय होते हैं। इनके कुछ उदाहरण छिपकली, सांप, तथा मच्छर हैं।

ध्रुवीय क्षेत्र की बर्फीली ठंड में अन्य प्रकार के अनुकूलन देखे जा सकते हैं। यहां पर पाए जाने वाले जन्तुओं का रंग प्रायः सफेद अथवा हल्का होता है। यह रंग उनके छद्मावरण तथा गर्मी को नियमित करने में सहायता करता है। यहां के जन्तु गर्मी तथा पतझड़ में बहुत खाते हैं और वसा के रूप में ऊर्जा को एकत्र कर लेते हैं। कड़ी सर्दी में कुछ माहों तक ये सोए रहते हैं अथवा शीतवास करते हैं। शीतवास में इनकी उपापचय क्रिया बहुत ही कम हो जाती है। यहां तक कि इन ठण्डे बर्फ से ढके हुए स्थानों में पाए जाने वाले पौधों की भी ऊंचाई कम होती है। ये महीनों तक प्रसुप्त अवस्था में रहते हैं। इनकी पतली अथवा कांटेदार पत्तियाँ होती हैं जिन्हें ये जल्दी-जल्दी गिरा देते हैं। प्रायः इन क्षेत्रों में वृक्ष नहीं मिलते क्योंकि वे इतनी ठण्ड में जीवित नहीं रह पाते हैं।

15.9 अनुकूलन कैसे होता है?

यह अनुकूलन कैसे होता है? जीव एकदम यह निर्णय नहीं ले पाते हैं कि वह अपने शरीर या जैविक गुणों को वातावरण के साथ बदल सकें। किसी स्पीशीज की बहुत बड़ी जनसंख्या में शायद कोई एक ऐसा जीव होगा जो दूसरों से कुछ भिन्न होगा। यह जीव अन्य जीवों की अपेक्षा वातावरण की परिस्थितियों को अच्छी तरह सहन करने में समर्थ हो सकता है। कुछ कीटों के उदाहरण लें। जब कोई कीटनाशक जैसे डी.डी.टी. डालते हैं तो बहुत सारे कीट मर जाते हैं। कीटों की उस बड़ी जनसंख्या में कुछ ऐसे भी कीट होंगे जिन पर डी.डी.टी. का कोई प्रभाव नहीं होगा। ये कीट वृद्धि करते हैं और इनमें प्रजनन होता है। यदि इस प्रकार प्रतिरोधक कीट प्रजनन करें तो शीघ्र ही उस क्षेत्र में प्रतिरोधक कीटों की जनसंख्या बढ़ जाएगी। इस नई संतति पर डी.डी.टी. जैसे कीटनाशक का कोई प्रभाव नहीं पड़ेगा। इसे हम वातावरण से अनुकूलित होना कहते हैं। बहुत से कीट जन्म से ही वातावरण के ताप से अनुकूलित होते हैं, परन्तु पशु तथा मनुष्यों में इस प्रकार का अनुकूलन नहीं होता है। यदि कड़ी ठण्ड में कपड़े पहनाकर या ढंक कर इनका बचाव न किया जाए तो यह जीवित नहीं रह पायेंगे। कीट समुद्र में नहीं रह पाते हैं इनका शरीर लवणीय जल सहन नहीं कर सकता।

हमने ऊपर उन जीवों का वर्णन किया है जो अपने वासस्थान से अनुकूलित थे। ऊपर दी गई जानकारी अनुकूलन के सफल उदाहरण हैं। हमने अभी तक असफलता के विषय में कुछ नहीं कहा है। डोडो एक पक्षी था जो मोरीशिस और तटीय अफ्रीका के टापुओं में रहता था परन्तु अब वह लुप्त हो गया है। जबकि ऑस्ट्रिच, मुर्गी तथा इमु जैसे पक्षी जीवित हैं तथा अच्छी तरह से फल-फूल रहे हैं। डोडो ऐसा क्यों नहीं कर सका?

ऊपर का उदाहरण इसलिए दिया गया है कि आप यह न सोचें कि जीव अपने आप को वातावरण के अनुकूल ढालने के लिए अपने में परिवर्तन करने का फैसला स्वयं कर लेते हैं। जीव ऐसा नहीं करते और न ही वे ऐसा कर सकते हैं। जीवों में स्थायी परिवर्तन आनुवांशिक या आनुवांशिक विधियों से होते हैं। अन्यथा परिवर्तन एक संतति से दूसरे संतति में नहीं आ पाते हैं। यदि हम चिकित्सा पद्धति से घोड़े की गर्दन को

लम्बी कर दें तो यह लंबी गर्दन उसकी संततियों में देखने को नहीं मिलेगी। वंशागत परिवर्तन के लिए जीव के गुण सूत्रों में परिवर्तन होना चाहिए। इसी प्रकार ऊँट की पानी के बिना रहने की विशेषता भी आनुवंशिक है और ये विशेषता पीढ़ी दर पीढ़ी चलती रहती है। यह उपार्जित विशेषता नहीं है, यदि ऐसा होता तो ये अगली संतति में नहीं पाया जा सकता है। केवल जो गुण सूत्रों में होता है वही अगली संतति में जाता है।

मरुस्थल में जानवरों की बहुत बड़ी जनसंख्या के विषय में सोचें। इन सब को जीवित रहना है जिसके लिए उन्हें भोजन प्राप्त करना है, प्रजनन करना और फलना फूलना है। इन सब प्रक्रियाओं को करने के लिए उन्हें वातावरण से अनुकूलित होना पड़ता है। इस वातावरण में उन जीवों के जीवित रहने की संभावना अधिक है जो पानी के बिना कुछ दिन रह सकते हैं बजाय उन जीवों के जिन्हें प्रतिदिन पानी की आवश्यकता होती है, बाद वाले जीव मरुस्थल में कुछ दिनों में मर जायेंगे। जो जीव कुछ दिन मरुस्थल में बिना पानी के रह सकते हैं उनके इन मरुस्थल में रहने के अधिक अवसर हैं। लेकिन कुछ पीढ़ियों के बाद क्या होगा?

जो जीव इस वातावरण के अनुकूल नहीं हैं उनकी जनसंख्या कम हो जाएगी और जो अनुकूल हो गए हैं उनकी जनसंख्या बढ़ जाएगी। इस प्रक्रम को प्राकृतिक वरण कहते हैं। क्योंकि इस वातावरण से तालमेल रखने वाले जीवों को कुछ वरणात्मक लाभ थे जिससे उनकी जनसंख्या धीरे-धीरे प्रभावी होती गयी। योग्यतम की उत्तरजीविता का सिद्धान्त इसी संदर्भ में प्रयुक्त किया जाता है। जो जीव अपने को वातावरण के अनुसार बदल लेते हैं वे बच जाते हैं और शेष नष्ट हो जाते हैं। स्पीशीज और जनसंख्या के प्राकृतिक वरण का प्रक्रम कुछ ही वर्षों में नहीं हुआ बल्कि कई हजार वर्षों में स्थापित हुआ है।

इसीलिए ऊंट मरुस्थल में बच गया है और उसने प्रजनन किया परन्तु मेंढक और ध्रुवी भालू मरुस्थल में नहीं बच पाए। ऊंट मरुस्थल के वातावरण में अच्छी तरह रह सकता है और अब यह इसका वास-स्थान बन गया है। ऊंट ने मरुस्थल में रहने या वहां अपना परिवार बढ़ाने का फैसला नहीं किया था। मरुस्थल में भौतिक वातावरण तथा ऊंट के जैविक अक्षर्यानिधि में अच्छा तालमेल रहा है। हमारा जीव विज्ञान में अनुकूलन शब्द का उपयोग करने का यही अर्थ है।

15.10 मनुष्य अपने वासस्थान को अपने अनुकूल बनाता है

जीव अपने वास-स्थान की परिस्थितियों में अस्थाई परिवर्तन करते हैं। जलकुम्भी की अत्याधिक वृद्धि तालाब के पोषकों को नष्ट कर देती है, इससे दूसरे जीवों की वृद्धि सुचारू रूप से नहीं हो पाती है।

कुछ जानवरों जैसे बाघ की पूर्व प्रभाविकता जंगल में रहने वाले अन्य जानवरों जैसे हिरण, जेब्रा को अन्य सुरक्षित स्थानों पर प्रजनन के लिए विवश कर देती है।

मनुष्य सफलता पूर्वक विभिन्न वास स्थानों में रह सकता है। मनुष्य ने समुद्रों तथा अन्टारटिक जैसे स्थानों का दोहन किया है। उन्होंने ऐसे

वातावरण का निर्माण किया है जो उनकी आवश्यकताओं के अनुकूल हो। इस प्रक्रम से वातावरण तथा वास-स्थानों मे बहुत तीव्र प्रत्यावर्तन हुए हैं।

आप मनुष्य के द्वारा वास स्थानों में लाये गए परिवर्तनों की एक सूची बनाएं। आपको पता लगेगा कि कृषि योग्य भूमि का उपयोग अन्य कार्यो जैसे कृषि, नागरीकरण तथा कारखाने लगाने में किया गया है। क्या तुम सोच सकते हो कि इन परिवर्तनों से स्वस्थ वातावरण का निर्माण भी होगा। मान लो कि विकास कार्य के लिए वनों को काट दिया जाए तो क्या आप बता सकते हैं कि इसका वातावरण पर क्या प्रभाव पड़ेगा? क्या इससे मिट्टी, पक्षियों तथा जानवरों पर कोई प्रभाव पड़ेगा? क्या इससे अधिक बाढ़ आ जाएगी?

क्रियाकलाप–4

एक बरतन लो। इसे 3/4 भाग पानी से भर दो। इसमें रेत डालें। आप देखेंगे कि पानी की सतह ऊपर उठ जाएगी। थोड़ा और रेत डालें, पानी बरतन से बाहर निकलना शुरू हो जाएगा। ऐसा नदी में भी होता है, जब अधिक मिट्टी बहकर नदी में आ जाती है। क्या इस प्रक्रम में तथा बाढ़ में कुछ समानता है? क्या जलाशय में अधिक मिट्टी या रेत के एकत्र होने पर बांध को कुछ हानि पहुंच सकती है?

प्रश्नावली

1. वासस्थान की परिभाषा लिखिए। आप इसे वातावरण से कैसे भिन्न समझते हैं?
2. ऐसी भौतिक अवस्थाओं की सूची बनाओ जो किसी वासस्थान की प्रकृति को निर्धारित करती हैं।
3. उदाहरण देकर किसी वासस्थान में स्पीशीज की परस्पर निर्भरता को समझाएं।
4. मनुष्य के दो परजीवियों के नाम बताइए। उनके वाहकों के नाम भी लिखें।
5. अनुकूलन क्या है? यह कैसे होता है?
6. तालाब या झील में पाए जाने वाले कुछ जलीय पौधों के नाम बताइए?
7. जलीय पौधे तथा जानवर क्षय होने से कैसे बच सकते हैं?
8. मछली पानी में कैसे गति करती है? उसे ऑक्सीजन लेने के लिए क्या करना पड़ता है?
9. आप जलीय पौधों में उत्प्लावकता की परिस्थितियों की कैसे व्याख्या करेंगे।
10. स्थलीय जीवों को प्रभावित करने वाले मुख्य भौतिक कारक कौन-कौन से हैं?
11. मरुस्थल में पाए जाने वाले पौधे पानी की हानि को कैसे रोकते हैं?
12. बिलकारी आदतें मरूस्थलीय जन्तुओं को पानी की कमी में जीवित रखने में किस प्रकार सहायक हैं?

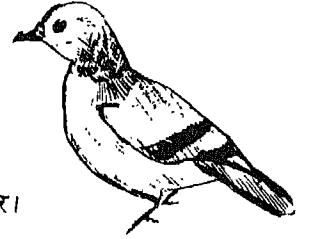
13. मरुस्थल में रहने के लिए ऊंट की अनुकूलता का वर्णन करिए।
14. गायों की संख्या नमी वाले वासस्थानों की अपेक्षा शुष्क तथा गरम वासस्थानों में अधिक होती है। इसके कारण बताइए।
15. गिरगिट की अनुकूलता की व्याख्या करिए।
16. ऐसे तरीकों की एक सूची बनाइए जो जीवों को हिमांक से कम ताप पर जीवित रखने में सहायता करते हैं।
17. जैविक दृष्टि से अनुकूलता के लिए जिन परिवर्तनों की आवश्यकता होती है उन्हें विस्तार से लिखें।
18. मनुष्य द्वारा वातावरण में हेर-फेर करने से अन्य जीवों के वास-स्थानों पर क्या प्रभाव पड़ता है?
19. वास-स्थान को उचित रूप से उपयोग करने के लिए आप क्या सुझाव देंगे?

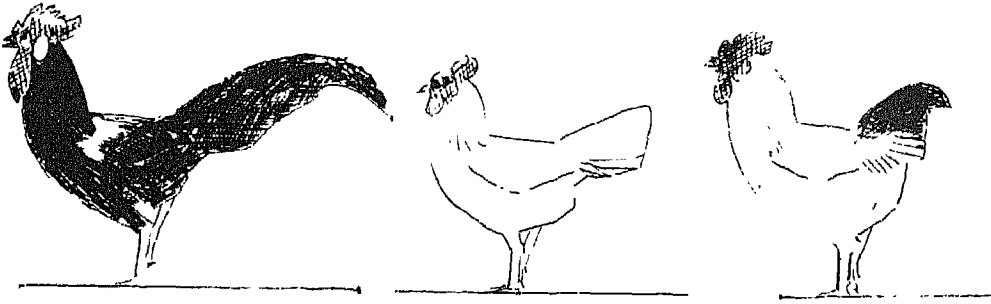
जीवन पद्धति : पक्षी का जीवन

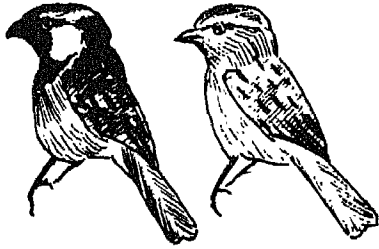
भूमिका

हम अपने चारों ओर विभिन्न प्रकार के जीव, जैसे केंचुआ तथा कीट, मछली तथा मेंढक, पक्षी, गिलहरी तथा बन्दर तथा विभिन्न प्रकार के पौधों को देखते हैं। इस विविधता का उद्गम क्या है? ये अपना अस्तित्व कैसे बनाए हुए हैं? ये कुछ ऐसे प्रश्न हैं जो हमारे सामने प्रायः उठते हैं। इन प्रश्नों के उत्तर हमें स्वयं खोजने चाहिए। यह अध्याय इसी उद्देश्य से लिखा गया है जिससे आपको अवलोकन के आधार पर अपने प्रश्नों का उत्तर स्वयं खोजने में सहायता मिले।

इस उद्देश्य की पूर्ति के लिए हमने पक्षियों का उदाहरण लिया है। इसका कारण यह है कि पक्षी सजीवता के साथ-साथ अपनी भव्य उड़ान, सुन्दर रंगों और मधुर स्वरों से हमारे मन को आकर्षित करते रहते हैं। भारत में प्रत्येक स्थान यहां तक कि बम्बई जैसे शहर में आप पक्षियों को अपना स्वाभाविक जीवन जीते हुए देख सकते हैं। उनकी शारीरिक रचना जैसे दो पैरों तथा पंखों के कारण उनको पहचानने में कोई भी गलती नहीं कर सकता। शहर में भी आप विभिन्न प्रकार के पक्षी देखते हैं पर उनकी संख्या प्राकृतिक वासस्थानों जैसे वृक्षों से घिरे स्थानों पर अधिक होती है।

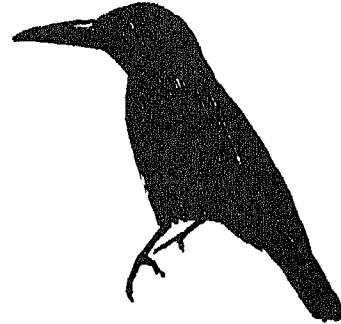
आइए इस अध्याय का आरम्भ पक्षी कितने प्रकार के होते हैं, से करें। यहां पर मुख्य शब्द है प्रकार। घरेलू कबूतरों या चूज़ों के झुण्ड को देखने का प्रयत्न कीजिए। कबूतर तथा चूज़े विभिन्न रंगों में दिखाई देंगे (चित्र 16.1)। उदाहरण-के लिए चित्र 16.2 को देखिए इस चित्र में **रैड रोडे आइलैंड, व्हाइट लैग हार्न, ब्लैक मिनोर्का** तथा **ब्राउन चिकन** (भूरा चूज़ा) दिखाया गया है।

चित्र 16.1 कबूतर।

हम इन्हें विभिन्न प्रकार का मान सकते हैं। इसी प्रकार चित्र 16.3 में दिखाई गई गौरेया को देखिये। आपको दो प्रकार की गौरेया दिखाई देंगी। इनमें से एक की पीठ लाल भूरे से रंग की,

चित्र 16.2 चूज़ा। रैड रोडे आई लैंड मुर्गा, व्हाइट लोगहार्न मुर्गी, तथा ब्लैक मिनोर्का मुर्गा।

सिर स्लेटी रंग का तथा दाढ़ी अर्थात् ठोडी से वक्ष तक का भाग् काले रंग का है, जबकि दूसरी के शरीर का सारा रंग हल्का भूरा सा है। वास्तव में पहली वाली गौरेया नर है तथा दूसरी मादा। आप इन्हें इनके घोंसलों के पास संभोग करते हुए देख सकते हैं।

चित्र 16.3 गौरेया। बाईं ओर नर, दाईं ओर मादा।

कौवे भी दो प्रकार के होते हैं। एक कौवे का रंग बिल्कुल काला होता है, (चित्र 16.4) दूसरा कौवा छोटा होता है और उसकी गर्दन स्लेटी रंग की होती है (चित्र 16.5)। बहुत से लोग सोचते हैं कि इनमें से पहला नर है तथा दूसरा मादा। लेकिन वास्तव में ऐसा नहीं है। ये चूज़ों तथा नर-मादा गौरेया के विभिन्न प्रकारों से सर्वथा भिन्न हैं क्योंकि कौवों के यह दोनों प्रकार आपस में संकरण नहीं कर सकते हैं। ये अलग अलग स्पीशीज के सदस्य हैं। स्पीशीज प्राकृतिक परिस्थितियों में संकरण करने वाले जीवों के एक

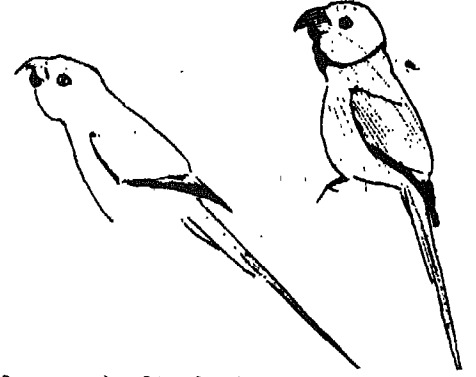
चित्र 16.4 सामान्य घरेलू कौवा जिसकी गर्दन स्लेटी रंग की है।

समूह को कह सकते हैं। इसीलिए प्रत्येक स्पीशीज पृथ्वी पर लैंगिक जनन करने वाले जीवों में जीवन

चित्र 16.5 जंगली कौवा यह बिलकुल काले रंग का है और घरेलू कौवे से लम्बा।

की विविधता की एक प्राकृतिक इकाई है। आइए हम अपना ध्यान पक्षी वर्ग की स्पीशीज पर केन्द्रित करें और स्पीशीज स्तर पर विविधताएं देखें।

संसार में पक्षियों की लगभग 8,600 स्पीशीज हैं जिसमें से लगभग 1200 स्पीशीज भारत में पाई जाती हैं। जब आप पक्षियों का अवलोकन करेंगे तब आपको दो स्पीशीज में अन्तर करना कठिन लग सकता है। वे दो अलग-अलग लिंग के हो सकते हैं, अथवा उसी स्पीशीज के बाल्य और वयस्क की अलग-अलग अवस्थाएं भी हो सकती हैं। लेकिन लगातार देखते रहने से कुछ समय बाद यह कठिनाई समाप्त हो जाएगी। प्रारम्भ में आप केवल इन पक्षियों के विभिन्न अंतरों को देखिये और उनके विशेष गुणों को लिखिए। उनका साइज, रंग, उनकी चोंच, टांगे, पूंछ तथा पंखों का माप तथा आकार, वे कहां पाए जाते हैं और क्या करते हैं आदि ही उनकी मुख्य विशेषतायें हैं।

आइये अब इस विषय में सोचें कि किसी आस पड़ोस में कितने प्रकार के पक्षी हैं और इन पक्षियों की संख्या इस क्षेत्र में इससे अधिक या कम क्यों नहीं है। इस प्रकार के वैज्ञानिक प्रश्नों के उत्तर खोजने के लिए हमें कुछ मानक विधि अपनानी चाहिए ताकि दूसरे विद्यार्थी भी हमारे अवलोकनों की पुनरावृत्ति कर सकें और देखें कि उत्तरों में समानता है या नहीं। चूंकि अवलोकनों की पुनरावृत्ति करना विज्ञान का एक प्रमुख अंग है। हम इस अध्याय के अन्त में प्रोजेक्ट्स के अन्तर्गत पक्षियों की विभिन्न स्पीशीज का अनुमान लगाने की एक मानक विधि की रूप रेखा बतायेंगे। इस विधि को रेखा खंड (line transect) कहते हैं और इस विधि में अवलोकनों की पुनरावृत्ति सुनिश्चित है। हमारा सुझाव यह है कि आप इस विधि को अपने अवलोकनों में उपयोग करें।

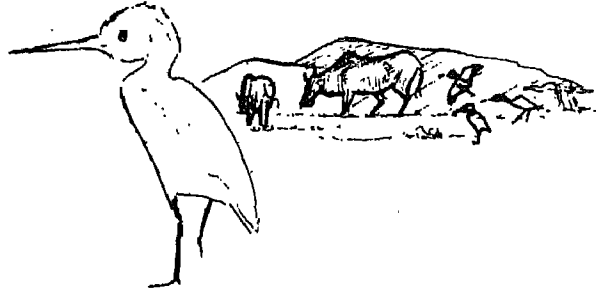
इस प्रकार के अवलोकनों को आप विभिन्न वास-स्थानों पर कर सकते हैं। कस्बों में जहां काफी खुला स्थान हो, बाग-बगीचों में तथा सड़क के किनारे लगे वृक्षों पर आपको बीस-पच्चीस स्पीशीज दिखाई दे सकती हैं। दूसरी ओर खुले रेतीले समुद्र के किनारे केवल 10-15 तक विभिन्न स्पीशीज देखी जा सकती हैं। सम्मिश्र वास स्थानों जैसे ताजा पानी के स्थानों जिसके चारों ओर धान के खेत तथा वृक्ष हों, पर आपको 30-35 स्पीशीज दिखाई पड़ सकती हैं। घने सदा बहार वनों में आपको 15-20 स्पीशीज ही दिखाई देंगी।

चित्र 16.6 रोज रिंग्ड पैराकीट। इसकी चोंच शक्तिशाली तथा वक्र होती है।

पक्षियों की किसी स्थान पर संख्या, स्पीशीज तथा उनके समुदाय की रचना को कौन निर्धारित करता है? पारिस्थतिक वैज्ञानिक पक्षियों के समुदाय को विभिन्न स्पीशीज का एक ऐसा समूह मानते हैं जिनमें प्रत्येक के जीने का तरीका थोड़ा भिन्न होता है। उदाहरण के लिए **रोजरिंग्ड पैराकीट** (चित्र 16.6) फलों को खाता है, और

चित्र 16.7 चित्तीदार कबूतर।

प्रतिदिन झुण्ड बनाकर बहुत बड़े क्षेत्र में उड़ान भरता है। जबकि चित्तीदार बत्तख किसी सीमित क्षेत्र में (चित्र 16.7) छोटे-छोटे दानों को खाती है।

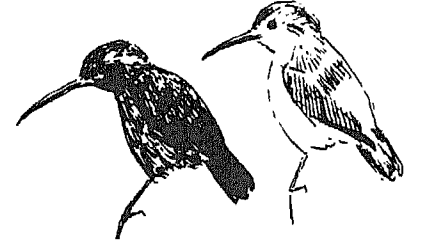
इस प्रकार हम देखते हैं कि दोनों की जीवन विधि में काफी अन्तर है। ये दोनों ब्लैक ड्रोंगों (चित्र 16.8) से भी भिन्न होते हैं। ड्रोंगों वृक्ष से उड़कर हवा में उड़ते हुए कीट का पीछा करता है। ये स्पीशीज छोटे कस्बों तथा बाग-बगीचे वाले शहरों में पाये जाने वाले पक्षी समुदाय की सदस्य हैं यद्यपि इनमें से प्रत्येक अपने जीवन यापन के लिए अपनी भिन्न-भिन्न विशिष्टताओं तथा विभिन्न संसाधनों का उपयोग करती हैं। विभिन्न प्रकार के वास-स्थान जैसे घास के नम मैदान में विभिन्न प्रकार के पक्षी दिखाई देंगे। ऐसे स्थानों पर कैटल एग्रेट (चित्र 16.9) दिखाई दे सकता है जो चरती हुई भैसों के पीछे पीछे जाता है और उनके चलने से कुचली हुई घास से कीड़ों को पकड़ कर खाता है। पक्षियों के प्रत्येक समुदाय में विभिन्न प्रकार के पक्षियों को देखिये। उनके वास स्थान तथा रहने का ढंग भिन्न होते हुए भी वे किस प्रकार समुदाय में रहते हैं? इसे स्पीशीज का **पारिस्थितिक कर्मता** कहते हैं। कर्मता (Niche) समुदाय में **पौधों तथा** जन्तुओं का स्थान तथा कार्य बताता है। विभिन्न स्पीशीज की पारिस्थितिक कर्मता भिन्न भिन्न होती है।

चित्र 16.8 ब्लैक ड्रोंगों। इसकी लम्बी कांटेदार पूंछ।

चित्र 16.9 कैटल एग्रेट जो चरती हुई भैसों के पीछे चलता है।

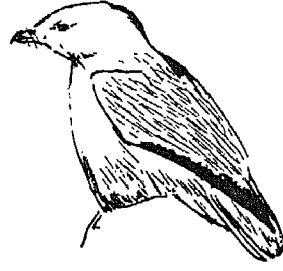
इससे पता लगता है कि विभिन्न प्रकार के समुदायों में स्पीशीज की संख्या कम अथवा अधिक क्यों होती है। वातावरण जितना सरलतम होगा उतना ही पारिस्थितिक कर्मता कम होगी तथा स्पीशीज की संख्या भी कम होगी। इसीलिए समुद्रों के रेतीले तटों पर 10-15

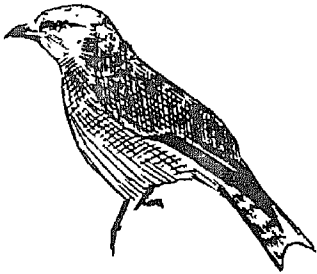
तक स्पीशीज होती हैं। इनमें से कुछ ही विभिन्न दूरियों पर रेत पर तथा कम उथले जल में भोजन की तलाश करती रहती हैं। यहां तक कि सदाबहार नमी वाले वनों में जहां वृक्ष वितान के रूप में हैं, वहां भी 15-20 तक ही स्पीशीज पाई जाती हैं जो कीट तथा फलों को भोजन के रूप में विभिन्न स्तरों पर लेती हैं। दूसरी ओर एक छोटे कस्बे में भी जिसके घरों के चारों ओर बाग हों विभिन्न वास-स्थान पाये जाते हैं। कस्बों की सड़कें तथा खेलने के मैदान, शुष्क पथरीले अथवा घास के मैदान वास-स्थान के रूप में हैं जहां पर झाड़ियां तथा वृक्ष कहीं-कहीं लगे रहते हैं। यहां पर कहीं-कहीं घनी झाड़ियों का समूह भी होता है इसलिए शहरों तथा कस्बों में 20-25 विभिन्न स्पीशीज पाई जा सकती हैं। जब आप पक्षियों को देखने के लिए बाहर जायें तो उनके वास-स्थानों के विषय में लिखिए और पक्षियों की स्पीशीज की संख्या तथा वास-स्थानों के सम्बन्धों को भी देखने का प्रयत्न करें।

आप पक्षियों का अवलोकन करते समय अन्य दिलचस्प क्रिया कलाप भी कर सकते हैं। इसमें आप पक्षी की शारीरिक रचना तथा व्यवहार की तुलना उसके रहन-सहन के तरीके से कीजिये। हमारा ऐसा विश्वास है कि विकास के इतिहास में पक्षी के शारीरिक रचना के वे गुण अथवा व्यवहार जो उसके जीवन के रहने के अनुकूल नहीं होंगे वे स्वयं लुप्त हो गये होंगे और ऐसे नये गुण उत्पन्न हुए होंगे जो कि उसके जीने के ढंग में सहायता कर सकें। इसके परिणाम स्वरूप प्रत्येक पक्षी अपनी जीने की आवश्यकता के अनुकूल हो गया होगा। अब हम अपने देश के 26 सामान्य पक्षियों का वर्णन करेंगे। हमें विश्वास है कि आप भारत में कहीं न कहीं इन पक्षियों को अवश्य देख पायेंगे।

हमारे सबसे सामान्य पक्षियों में कौवे की दो स्पीशीज आती हैं। उनमें से एक बिलकुल काला, लंबा, जंगली कौवा (चित्र 16.5) है तथा दूसरा इसका सर्वतोमुखी घरेलू कौवा है (चित्र 16.4) जिसकी गर्दन स्लेटी रंग की है। कौवा एक मजेदार पक्षी है जो सब चीजें, जैसे फूलों का मकरन्द, फलों, दानों से लेकर कीटों तक, सभी पक्षियों के बच्चे तथा अण्डे एवं मरे हुए चूहे तक खा जाता है। उसकी चोंच को देखें। यह मजबूत सीधी तथा लंबी है लेकिन कोई विशिष्ट कार्य के लिए नहीं होती है। इसी चोंच के कारण ये विभिन्न प्रकार के भोजन को खा सकता है। इसकी चोंच की तुलना शकरखोरों (sun birds) की चोंच से करें।

चित्र 16.10 शकरखोरा : इसकी चोंच लम्बी, पतली तथा वक्र होती है।

शकरखोरे (चित्र 16.10) छोटे, चुस्त पक्षी होते हैं जिनकी चोंच लंबी, पतली तथा मुड़ी होती है। आप उन्हें प्रायः मकरन्द चूसते हुए बागों में देख सकते हैं। ये मकरन्द ऐसे फूलों से चूसते हैं, जिनका फूल नली के आकार का होता है जिसमें ये अपनी चोंच आसानी से डाल सकते हैं। हमारा अन्य मनपसन्द पंक्षी है तोता या रोजरिंग पैराकीट (चित्र 16.6)। इसकी चोंच बहुत

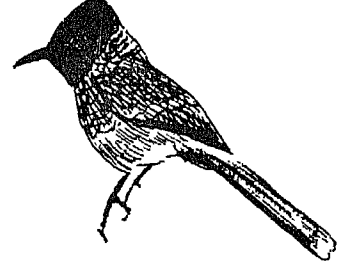
मजबूत तथा मुड़ी होती है। इसकी चोंच हरे-हरे अमरूदों के गूदे में घुस जाती है जिनसे यह अपना भोजन प्राप्त करता है। मजबूत मुड़ी हुई चोंच माँसाहारी पक्षियों की भी होती है जिसे वे चूहे जैसे जीवों की सख्त खाल की चीर-फाड़ करने में उपयोग करते हैं। माँसाहारियों में हमारा सामान्य पक्षी चील है। उनमें से एक काले से भूरे रंग की परिहा चील है जिसकी पूँछ कटावदार होती है (चित्र 16.11) तथा दूसरी है लाल एवं सफेद ब्राहमणी चील (चित्र 16.12)।

छोटा चित्तीदार उल्लू तथा बड़ा बार्न उल्लू दो अन्य माँसाहारी पक्षी हैं जो रात में घूमते हैं। इनकी चोंच भी मजबूत तथा मुड़ी हुई होती है (चित्र 16.14)। इन निशाचर पक्षियों में एक विचित्र गुण यह है कि इनकी बड़ी-बड़ी आँखें चपटे चेहरे पर लगी रहती हैं जिससे कि वे मध्यम प्रकाश में अपने शिकार पर ठीक निशाना बना लेते हैं।

आइए अब दूसरी विशेषता पंखों के बारे में विचार करें। अपने-अपने जीवन के तरीकों के

चित्र 16.11 काली तथा भूरे रंग की परिहा चील। इसकी पूंछ होती है।

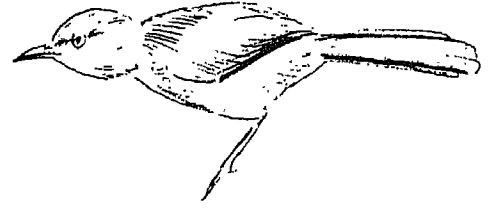
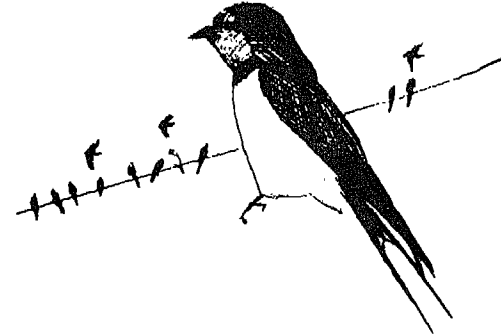
चित्र 16.12 ब्राहमणी चील।

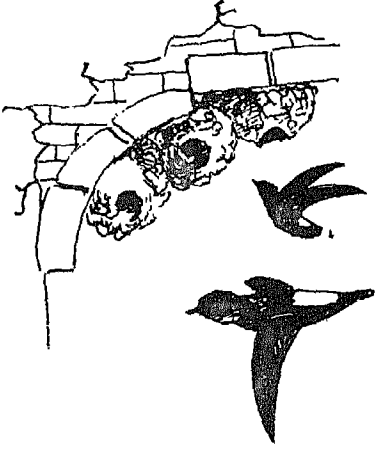
चित्र 16.13 चित्तीदार उल्लू इसका माप छोटा होता है तथा इसके शरीर पर चित्तियां होती हैं।

चित्र 16.14 बार्न उल्लू इसकी बड़ी-बड़ी आंखें और चपटे चेहरे को देखें।

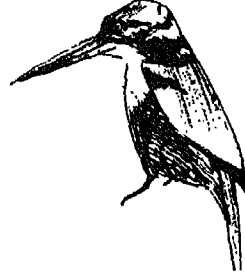
अनुसार पक्षी विभिन्न ढंगों से उड़ते हैं। कापर स्मिथ (चित्र 16.15) एक छोटा पक्षी है जो हमारे बागों में हरे फलों को खाता रहता है। इसका नाम कुक-कुक की लगातार आवाज के कारण पड़ा है जो ठठेरे के कार्य करने के दौरान उत्पन्न होती है। फल खाने वाले इस पक्षी को बहुत कम उड़ने की आवश्यकता होती है वह भी बहुत धीरे-धीरे। क्योंकि यह एक वृक्ष या झाड़ी से दूसरे वृक्ष या झाड़ी तक ही जाता है। इसीलिए इसको तेज उड़ने की अथवा अपने पंखों द्वारा काफी समय तक सर्पण करने की आवश्यकता नहीं है। इसके पंख छोटे तथा चौड़े होते हैं जो इस प्रकार की उड़ान के लिए उपयुक्त हैं। बुलबुल (चित्र 16.16) की भी आदत ऐसी ही होती है जो मुख्यतः सरस फल खाती है। बैब्लर का भी चलने का तरीका (चित्र 16.17) बुलबुल तथा कापर स्मिथ की तरह होता है। बैब्लर कीट भक्षी होता है, ये झुण्ड बनाकर खाता है तथा किसी छोटे से क्षेत्र में धीरे-धीरे एक झाड़ी से दूसरी झाड़ी तक जाता है। इसे उड़ने की कोई विशेष आवश्यकता नहीं होती है। इसके पंख भी छोटे तथा चौड़े होते हैं। अबाबील (चित्र 16.18) तथा बतासी (चित्र 16.19) में यह गुण इनके बिल्कुल विपरीत हैं। ये पक्षी सारा दिन उड़ते हैं क्योंकि ये हवा में उड़ने वाले कीटों को अपना भोजन बनाते हैं।

चित्र 16.16 बुलबुल।

चित्र 16.17 बैब्लर।

चित्र 16.15 छोटे तथा चौ॰ पंखों सहित कॉपर स्मिथ।

चित्र 16.18 अबाबील जो उड़ते हुए कीटों को खाता है।

इसलिए इन्हें कीटों को पकड़ने के लिए तेज उड़ना पड़ता है। इनके पंख लम्बे, पतले तथा थोड़े मुड़े हुए होते हैं। ऐसे पंख लंबे समय तक तेज उड़ने के लिए उपयुक्त होते हैं।

चित्र 16.19 बतासी : लम्बे तथा वक्र पंख जो बतासी तथा अबाबील को तेज उड़ने में सहायता देते हैं।

आइए अब हम पूँछ के विषय में विचार करें। पूँछ संतुलन बनाये रखने वाला अंग है। उड़ान के समय यह पक्षी को मुड़ने में भी सहायता करती है। उड़ान के समय शीघ्रता से मुड़ने वाला पक्षी ब्लैक ड्रोंगों है (चित्र 16.8) जो उड़ते हुये कीटों जैसे ड्रेगन फ्लाई को पकड़ता है। लम्बी कांटेदार पूँछ इसकी मुख्य विशेषता है। मधुकराश (चित्र 16.20) एक छोटा हरे रंग का पक्षी है जिसकी भोजन सम्बन्धित आदतें ब्लैक ड्रोंगों के समान हैं। इसकी एक लम्बी पूँछ तथा दो लम्बे पर होते हैं। जब यह मधुमक्खियों एवं अन्य कीटों को पकड़ने का प्रयत्न करता है उस

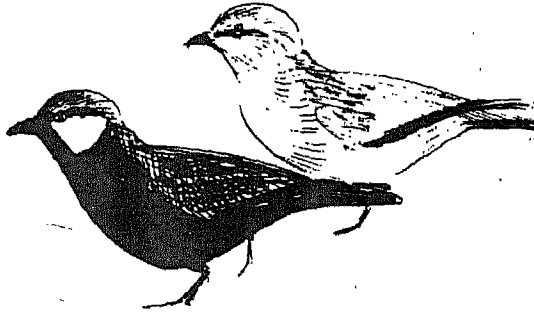
चित्र 16.20 मधुकराश : इसकी लम्बी पूंछ तथा दो बड़े पंखों को देखो।

चित्र 16.21 सफेद छाती वाला किलकिला। यह बड़ी तेज गति से चल सकता है।

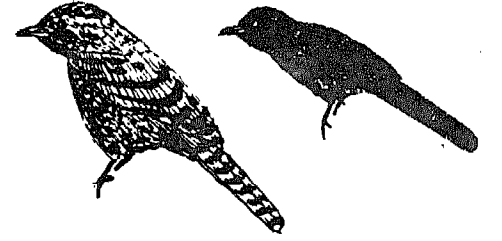
चित्र 16.22 सामान्य मोर। मोर की तरह मोरनी में पूंछ नहीं होती।

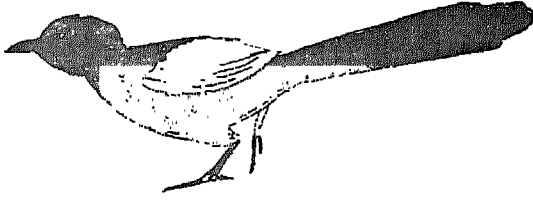
समय इसकी कला बाजियां देखने योग्य होती हैं। सफेद वक्ष वाला किलकिला (किंगफिशर) (चित्र

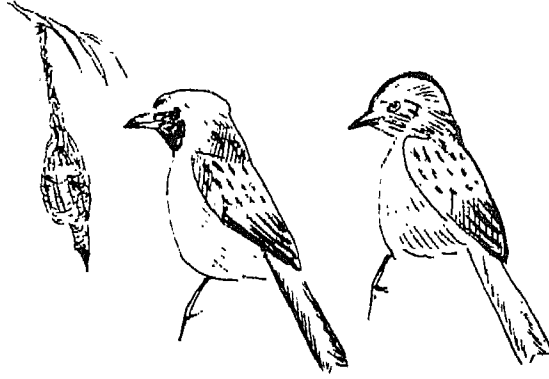
16.21) धरती पर ही कीटों को ढूंढता है और सीधे ही उन पर झपट्टा मारता है। वास्तव में इसकी पूंछ बहुत छोटी तथा मोटी होती है। मोर (चित्र 16.22) की पूँछ एक अपवाद है और वह उसे उड़ने में कोई सहायता नहीं करती है।

टांगों तथा पंजों को भी देखिये। शिकारी पक्षियों जैसें चील तथा उल्लू के पंजे बड़े तेज होते हैं लेकिन टांगें मध्यम माप की होती हैं। लम्बी टांगें ऐसे पक्षियों में होती हैं जो उथले पानी में रहने वाले कीटों तथा मछलियों पर निर्भर रहते हैं। सामान्य केटल एग्रेट (चित्र 16.9) की ऐसी ही लंबी टांगें होती हैं।

पक्षियों के रंग को भी देखो। बहुत से पक्षी अपने रंग का उपयोग अपने वातावरण से घुल-मिल जाने के लिए करते हैं। ऐसे पक्षी खुले बंजर स्थानों पर जहाँ छिपने के लिए और कोई स्थान नहीं होता, पाए जाते हैं। **ऐशी-क्राउन्ड फिंचलार्क** (चित्र 16.23) ऐसे ही स्थानों पर पाया जाता है, जहां पर उसका भूरा तथा काला रंग वहां की मिट्टी, चट्टान तथा घास से घुल-मिल जाने के लिए उपयुक्त होता है।

चित्र 16.23 ऐशी-क्राउंड फिन्च लार्क जो वातावरण में घुल मिल जाती हैं।

केवल शरीर की रचना ही नहीं अपितु पक्षी का व्यवहार भी महत्वपूर्ण है, जो उनको ऐसा जीवन यापन करने के अनुकूल बनाता है। इनमें भी बहुत सी मन लुभावनी विविधताएँ होती हैं। संकरण (जनन) करना पक्षियों के जीवन का एक मुख्य अंग है। उनमें से सबसे अद्भुत है घोंसलों पर परजीवी होना। ये ऐसे पक्षी हैं जो दूसरे पक्षियों द्वारा बनाए गए घोंसलों में अपने अंडे देते है और उन्हें वहीं बढ़ने देते हैं। इसका मुख्य उदाहरण है कोयल (चित्र 16.24) जो कौवे के घोसलों में अंडे देती है। इसका कारण यह है कि मादा कोयल कौवे की शक्ल से मिलती है।

चित्र 16.24 कोयल। बाईं ओर नर है।

हमारा सुझाव है कि आप ध्यान से कौवें तथा कोयल के बीच पारस्परिक क्रियाओं को देखें और पता लगाने का प्रयत्न करें कि कोयल किस प्रकार कोवे के घोसले में अण्डे देने के लिए प्रबन्ध करती है। कोयल के सभी सम्बन्धी घोंसले के परजीवी नहीं होते। इनमें से सबसे मुख्य पक्षी जो अपने चूज़े का स्वयं लालन-पालन करता है, वह हमारे बागों के आस-पास ही पाया जाता है। यह पक्षी है कौकल। यह काले रंग का होता है जिसके पंख भूरे से लाल रंग के होते हैं और पूँछ लम्बी होती है (चित्र 16.25)।

चित्र 16.25 कोकल : इसके पंख भूरे तथा पूंछ लम्बी होती है।

अपने चूज़ों का स्वय लालन-पालन करने वाले पक्षी ऐसा करने के लिए विभिन्न प्रकार के प्रबन्ध करते हैं। अधिकांश पक्षी जोड़े बनाकर अपने चूज़ों को पालते हैं। चूंकि चूज़ों की वृद्धि दर बहुत अधिक होती है। इसका वजन कुछ ही सप्ताह में वयस्क के भार के बराबर हो जाता है और यही कारण है कि दोनों माता-पिता इस दौरान बहुत कार्यशील रहते हैं। गौरेया अथवा ब्लूराक कबूतर को देखें जो प्राय: घरों में घोंसला बनाते हैं। देखिये, ये अपने बच्चों का लालन पालन करने में कितने क्रियाशील रहते हैं। कुछ पक्षी ऐसे भी हैं जिन्होंने इस समस्या का समाधान कर लिया है और वे चूज़ों का लालन-पालन विशिष्ट संरक्षित नलियों में करते हैं। उनकी वृद्धि दर अपेक्षाकृत कम होती है। इसलिए उनको अधिक भोजन देने की आवश्यकता नहीं होती है। इसका मुख्य उदाहरण बया है (चित्र 16.26)। बया में नर कई मादाओं से संभोग करता है। यह बहुत बड़ा घोंसला बनाने का उत्तरदायित्व लेता है। लेकिन चूज़ों को खाना खिलाने का काम मादाओं पर छोड़ देता है। यदि आप खोजें तो बया के घोंसले कीकर अथवा खजूर के पेड़ों पर बहुत संख्या में लटके हुए दिखाई देंगे। इन पक्षियों को सम्भोग करते देखना बहुत ही अच्छा लगता है। इनकी विशिष्ट आवाज सीटी के रूप में होती है, जो नर द्वारा सम्भोग के लिए दी जाती है। आपको मादा को अपने घोंसलों में बुलाने के लिए नर बया द्वारा प्रदर्शित व्यवहार को भी देखना चाहिए।

चित्र 16.26 बया पक्षी। बया के बुने हुए घोंसले को देखो।

अण्डे देने के लिए विभिन्न पक्षियों द्वारा विभिन्न प्रकार के घोंसले बनाये जाते हैं। सामान्य पक्षियों के घोंसलों को आप बड़ी आसानी से देख सकते हो। लेपविंग तथा बतख अपने घोंसले जमीन पर ही बनाते हैं। अन्य पक्षी जैसे मैना (चित्र 16.27), तोता (चित्र 16.6), किलकिला (चित्र 16.21) तथा कठफोड़वा वृक्षों में पाये जाने वाले प्राकृतिक गुहिकाओं में घोंसले बनाते हैं। बतासी तथा अबाबील (चित्र 16.18, 16.19) चट्टानों पर बहुत सारी मिट्टी इकट्ठी करके घोंसला बनाते हैं। बया (चित्र 16.26) जो रेशों से बहुत बड़ा लटकने वाला घोंसला बनाते हैं तथा दर्जिन पक्षी जो पत्तों को सिलकर घोंसला बनाते हैं कुछ ऐसे सामान्य उदाहरण हैं जो घोंसला बनाने की कारीगरी और दक्षता दिखाते हैं।

आप मुर्गी पालन केन्द्रों में अण्डे से चूजा निकलने की प्रक्रिया को आसानी से देख सकते हैं। आप देखेंगे कि नवजात चूज़ों पर छोटे-छोटे पंख होते हैं, उनकी आंखे खुली होती हैं। वह तुरन्त चलना और स्वयं खाना आरम्भ कर देते हैं। ऐसे पक्षियों को **नीडीफूगस** (Nidifugus) कहते हैं जिसका अर्थ होता है "घोंसले से भागना"। ऐसा इसलिए होता है, क्योंकि अंडजोत्पत्ति के समय ये पक्षी पूर्ण विकसित होते हैं और घोंसलों को तुरन्त छोड़कर अपना ध्यान स्वयं रखते हैं। इसके विपरीत कुछ अन्य पक्षियों के नवजात चूज़े पर पंख नहीं होते हैं। उनकी आंखें बन्द होती हैं और वे पूर्ण रूप से निर्भर होते हैं। आपने चिड़ियों तथा अन्य पक्षियों के बच्चों को देखा होगा जो अकस्मात घोंसलों से गिर गये हों, ऐसे पक्षियों को **नीडीकोलस** (Nidicolous) कहते हैं जिसका अर्थ होता है घोंसलों में रहने वाले। ये पक्षी कई सप्ताह तक घोंसलों में रहते हैं। इनके माता-पिता तब तक इन्हें भोजन तथा ऊष्मा देते हैं और सुरक्षा करते हैं जब तक इनकी आंखें नहीं खुल जाती हैं, पूर्ण रूप से विकास नहीं हो जाता और ये उड़ने योग्य नहीं हो जाते हैं।

घोंसले पक्षियों के व्यवहार के अनुसार कितने उपयुक्त हैं उस पर विचार कीजिए। शोर करते हुए पक्षियों के झुण्ड को आपने शाम को पेड़ों के आस पास अवश्य देखा होगा। इस समय वे सारे दिन भोजन की खोज करने तथा उड़ने के पश्चात आराम करने की तैयारी कर रहे होते हैं। इसे निलयन (Roosting) कहते हैं। जो पक्षी दिन में सक्रिय होते हैं वे रात में विश्राम करते हैं जबकि निशाचर पक्षी जैसे उल्लू तथा नाईटजार दिन के समय विश्राम करते हैं। कुछ पक्षी जैसे कोयल (चित्र 16.24) अकेली विश्राम करती है। अन्य पक्षी जैसे बुलबुल (चित्र 16.16) छोटे-छोटे समूहों में विश्राम करती हैं। लेकिन मैना (चित्र 16.27) बड़े-बड़े समूहों में विश्राम करने के लिए प्रसिद्ध हैं। कुछ पक्षी जैसे कि मैना, घरेलू कौवा,

?7 मैना।

जंगली कौवा तथा तोता (चित्र 16.4, 16.5, 16.6) बड़े समूहों में विश्राम क्यों करते हैं? इसके तीन लाभ होते हैं। (1) विश्राम करने वाले सदस्य एक दूसरे की गर्मी प्राप्त कर सकते हैं (2) समूह में कोई न कोई पक्षी जागरूक होता है जो भक्षक को देख सके और दूसरों को इसकी सूचना दे सके (3) यह भी सम्भव है कि वह समूह एक सूचना केन्द्र के रूप में कार्य करता हो जिसमें किसी पक्षी ने कहीं कोई भोजन का अच्छा स्रोत देखा हो तो वह दूसरों को बता दे।

भारत में पाए जानी वाली 1200 स्पीशीज में से 900 सारे वर्ष यहीं रहती हैं और जनन करती हैं। शेष 300 स्पीशीज प्रवासी हैं। वे एशिया तथा यूरोप के उत्तरी भागों में हिमालय को पार करके आती हैं। इन क्षेत्रों की अधिक सर्दी से बचने के लिए तथा मध्य और दक्षिणी भारत की गर्मी और लम्बे दिनों का आनन्द लेने के लिए वे

यहा पर प्रवास करती हैं। सर्दियों में प्रवासी पक्षियों के बत्तख, गीज, वेगटिल तथा फ्लाईकेचर प्रमुख उदाहरण हैं। ये सितम्बर या अक्तूबर में हमारे यहाँ आती हैं और मार्च या अप्रैल में वापिस चली जाती हैं। यदि आप सारे वर्ष अलग-अलग समय पर पक्षियों को देखो तो आपको पता चलेगा कि जो पक्षी आपने सर्दियों में देखे थे वे गर्मियों में नहीं हैं।

मनुष्यों की तरह पक्षी भी दृष्टि तथा आवाज पर काफी निर्भर करते हैं। यही कारण है कि वे हमें बहुत आकर्षक लगते हैं। हमारा सुझाव है कि पक्षियों के व्यवहार को बड़े ध्यान से देखिये और सुनिये। यहां तक कि सामान्य कौवा भी हमारे ज्ञान में वृद्धि कर सकता है। "मोबिंग" इसका एक प्रमुख स्वभाव है। अपनी कर्कश आवाज से यह चीलों तथा अन्य पक्षियों के पीछे उड़कर यहाँ तक कि मानव को भी परेशान करता है। इसे ही मोबिंग कहते हैं। इसकी बारंबारता समय और इसके द्वारा तंग होने वाले जीवों का एक रिकार्ड क्यों न बनाया जाए? इसके बाद आप यह निष्कर्ष निकाल सकते हो कि इस व्यवहार का उसे क्या लाभ है?

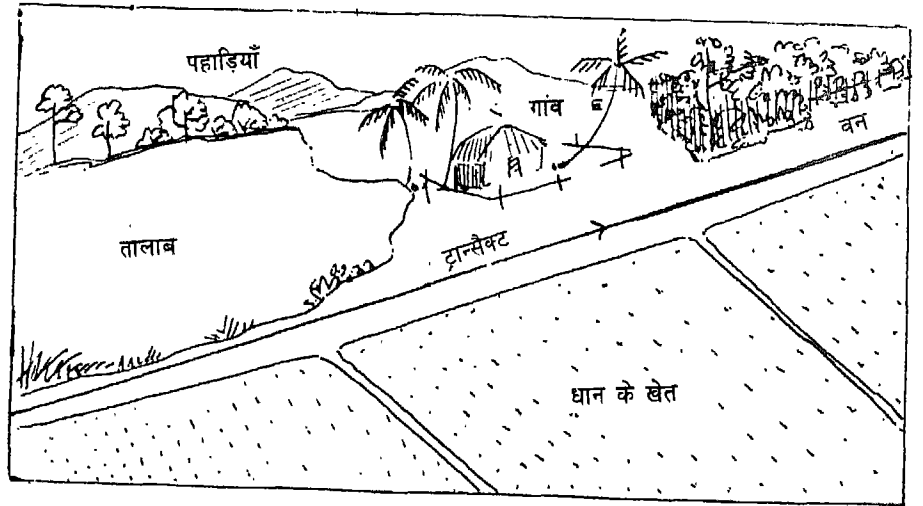
केवल कौवा ही नहीं बल्कि अन्य पक्षी भी शिकारी पक्षियों, सांपों अथवा बिल्ली को देखकर शोर मचाते हैं तथा अन्य संकट की सूचना देते हैं। सबसे अद्भुत बात यह है कि विभिन्न स्पीशीज की संकट कालीन सूचना की आवाज एक जैसी होती है। वास्तव में विभिन्न स्पीशीज इस आवाज को समझती हैं और एक दूसरे को संकटकालीन आवाज का उत्तर देती हैं। संकटकालीन आवाज इस प्रकार की जाती है कि सूचना देने वाले का पता लगाना कठिन होता है। इससे यह लाभ होता है कि सूचना देने वाला पक्षी अधिक सुरक्षित रहता है। इसके बिल्कुल विपरीत नर बया तथा अन्य पक्षियों की सम्भोग की आवाज का स्रोत पता करना बहुत ही आसान होता है। इससे नर को लाभ होता है।

इस प्रकार पक्षियों की रचना तथा व्यवहार हमें ऐसे काफी अवसर देते हैं जिससे पता लगे कि जीव अपने जीवन-यापन के लिए विभिन्न प्रकार के अनुकूलन अपनाता है। इनके विषय में पढ़ना मनोरंजक है। लेकिन स्वयं बाहर जा कर इनका प्रेक्षण करना और भी ज्यादा अच्छा लगता है। पक्षियों को देखते समय यदि आपको और अधिक विवरण का पता लगाना हो तो "बम्बई नेचुरल हिस्ट्री सोसाइटी" द्वारा प्रकाशित स्वर्गीय डा. सलीम अली की पुस्तक "इन्डियन बर्ड्स" को पढ़ें। लेकिन याद रखो डा. सलीम अली के पास ऐसी कोई संदर्शिका नहीं थी। उन्होंने पक्षियों के बारे में सब कुछ प्रेक्षणों के आधार पर सीखा। आपको भी ऐसा ही करना चाहिये।

करने के लिए प्रोजेक्ट

1. उन पक्षियों की संख्या आसानी से बढ़ाई जा सकती है जिनकी आप पहचान कर सकते हो। ऐसा करने के लिए सबसे पहले आप साधारण से साधारण पक्षी जिसे आप जानते हों जैसे घरेलू कौवा, जंगली कौवा, गौरेया अथवा कबूतर से आरम्भ करें। अपनी कापी में अपने ही शब्दों में प्रत्येक स्पीशीज का विवरण लिखें और जब आप उसी पक्षी

को दोबारा अच्छी तरह से देखें तो उस विवरण में संशोधन करते रहें। जिस पक्षी को आप अभी तक न पहचान सके हों उसका भी विवरण लिखें और उसे अपनी ओर से कोई अस्थायी नाम दे दें। उसके बाद किसी से पूछ कर अथवा डा. सलीम अली की पुस्तक देख कर उस पक्षी का सही नाम लिख दें। ऐसा करने से यह आपकी आदत बन जाएगी कि कहीं पर भी आप जायेंगे आप पक्षी को पहचान सकेंगे। इनके अंग्रेजी में सामान्य नाम भी याद रखना लाभदायक है। अधिकांश लोग इनके वैज्ञानिक नाम याद रखने का प्रयत्न नहीं करते।

2. रेखा खंड विधि से किसी क्षेत्र में पक्षियों की संख्या और विविधताएं पता करने का प्रयत्न करें। इस क्रियाकलाप का यह उद्देश्य है कि आप उस क्षेत्र में पाये जाने वाले सभी पक्षियों के सभी स्पीशीज के बारे में लिखें। लेकिन पक्षी गतिशील जीव होते हैं, इसलिए वे एक क्षेत्र में कभी पाये जा सकते हैं कभी नहीं। अतः पक्षियों के लिए इस प्रकार के प्रेक्षण हेतु एक विशेष अवधि को ही ध्यान में रखना चाहिए। इसकी सबसे अच्छी विधि यह है कि किसी निर्धारित दूरी तक सीधी रेखा में चलें। इसके लिए आप 600 मीटर चलें। लेकिन प्रत्येक दस मीटर के बाद 2 मिनट के लिए रुकें। क्योंकि आप 10 मीटर की दूरी कुछ ही सेकंड में पार कर लेंगे अतः इस सारी क्रिया में लगभग 2 घण्टे लग सकते हैं। इस चाल से आप किसी समतल मैदान, सीधी पहाड़ी, नदी नालों पर इस क्रियाकलाप को आसानी से कर सकते हैं। ताकि इस विधि से अलग-अलग स्थानों पर थोड़ा अंतर दिखाई दे सके। इस अवलोकन को प्रातः 7 से 9 बजे के बीच

चित्र 16.28 रेखाखंड (लाईन ट्रान्सैक्ट) का चित्र।

करिए। जब आप दो मिनट के लिए रुकें तब रेखा के दोनों ओर 100-100 मीटर तक पक्षियों का प्रेक्षण करें। आप दूरी के माप का मानक इस तरीके से पता कर सकते हैं कि दस मीटर में आप कितने कदम चले। इस प्रकार आप अपनी दृष्टि से 100 मीटर की दूरी का अनुमान लगा सकते हैं।

आप रेखा खंड की क्रियाकलाप से पक्षियों की आबादी का आंकलन कहीं पर भी कर सकते हैं। इस तरह की क्रिया करने के लिए आपको भरतपुर, रंगनाथिटू या करनाल स्थित पक्षी विहार (Sanctuary) में जाने की आवश्यकता नहीं है। आप इस क्रियाकलाप को स्वयं अथवा समूह में अनेक बार करके तथा परिणामों की तुलना करके मनोरंजक बना सकते हैं। जिन पक्षियों के नाम आप नहीं जानते उनका विवरण लिखते समय आप केवल नम्बर या अक्षर से जैसे स्पीशीज I या स्पीशीज 'अ' से अंकित कर सकते हैं। आप पता करें कि ऐसे पक्षी कितने प्रकार के हैं। लेकिन जब कभी आपको इनका नाम पता लगे तो इनका नाम लिख दें।

पहले इस अभ्यास को उसी क्षेत्र में कई अलग-अलग दिनों में करें और विभिन्न दिनों में पाए जाने वाली स्पीशीज तथा प्रत्येक सदस्य की संख्या की तुलना करें। जैसे-जैसे आप अवलोकन को जोड़ते जायेंगे क्रमशः स्पीशीज की संख्या बढ़ती जाएगी। यह ज्ञात होगा कि किसी भी दिन दो घण्टे की अवधि में आपको पक्षियों की आबादी का थोड़ा ही अंश दिखाई देगा।

3. रेखा खंड विधि को एक या दो भिन्न वास स्थानों पर करके देखिये और उनके परिणामों की तुलना कीजिये। देखिये कि किस वास स्थान में ज्यादा पक्षी या स्पीशीज हैं। अलग-अलग वास स्थानों में सामान्य स्पीशीज की गणना करिये। चूंकि पक्षियों को देखना एक जीवन पर्यन्त शौक बन सकता है आप अलग-अलग वास स्थानों पर पाये जाने वाले पक्षियों के विषय में मौलिक ज्ञान प्राप्त कर पायेंगे।
4. रेखा खंड विधि को उसी स्थान पर विभिन्न ऋतुओं में करिये। प्रवासी पक्षियों को पहचानने का प्रयास तथा उनकी तुलना डा. सलीम अली की पुस्तक से करें।
5. अधिक से अधिक पक्षियों की भोजन संबंधी आदतों की सूची बनाइये। यह क्रिया विभिन्न पक्षियों के लिए करें उदाहरणतः मैना तथा गौरेया, जो फुदक फुदक कर मैदानों में पाये जाने वाले कीटों अथवा बीजों को खाती हैं, मधुकराश जो उड़ती हुई मधुमक्खियों तथा उनके छत्तों पर आक्रमण करती है अथवा चीलें जो मृत जन्तुओं को देखकर नीचे आती हैं। पक्षियों के भोजन लेने की आदतों का सम्बन्ध शरीर की रचना और उनके व्यवहार से करें।
6. जब आप पक्षियों को देखना प्रारम्भ करेंगे तब आप बहुत से घोंसले भी देखेंगे। घोंसलों की आकृति तथा संरचना, सामग्री जिससे वह निर्मित हैं, वह स्थान जहाँ वे बने हैं और

यदि सम्भव हो सके तो उस पक्षी का नाम जिसका घोंसला है, की एक सूची बनायें।

7. जो पक्षियों का प्रेक्षण करने में रुचि रखते हैं उनके लिए विभिन्न पक्षियों की आवाज पहचानना आनन्ददायक होगा। आप जल्दी ही जान जायेंगे कि कुछ पक्षी अन्य पक्षियों की नकल करने में बहुत दक्ष होते हैं। उदाहरणत: ड्रोंगों। क्या आप अनुमान लगा सकते हैं कि ड्रोंगों की यह योग्यता उसे किस प्रकार सहायता करती है?

8. यदि आप शाम के समय पक्षियों के एकत्र होने का स्थान देख सकें तो आपको उनके निलयन के स्वभाव के विषय में पता लगेगा। यह पता लगाना आसान होगा कि कौन सी स्पीशीज मिलकर निलय करती हैं, वह किस समय पहुंचती हैं, किस क्रम में और कितनी देर तक वे फड़फड़ाने का शोर करती हैं और सोने से पहले किन-किन चीजों को प्रदर्शित करती हैं? कुछ पक्षियों के रहने के तरीकों के बारे में जानने का प्रयत्न करें जो उन्हें निलय करने में सहायता करते हैं।

प्रश्नावली

1. स्पीशीज की परिभाषा दो।
2. संसार में तथा भारत में पक्षियों की कितनी विभिन्न स्पीशीज हैं?
3. पक्षी की पहचान करते समय आप किन-किन महत्वपूर्ण विशेषताओं को देखेंगे?
4. पारिस्थितिक कर्मता क्या है? सामान्य कौवे और एग्रेट की कर्मता क्या है?
5. पतली तथा मुड़ी हुई चोंच के क्या लाभ हैं?
6. छोटे तथा चौड़े पंख बुलबुल तथा बैब्लर की किस प्रकार सहायता करते हैं? अबाबील तथा बतासी में लम्बे, पतले पंख क्यों होते हैं?
7. ब्लैक ड्रोंगों की लम्बी तथा कटावदार पूंछ के क्या लाभ हैं?
8. नीडीफूगस तथा नीडीकोलस पक्षी किन्हें कहते हैं? प्रत्येक के दो-दो उदाहरण दीजिए?

अध्याय 17

सजीव जगत में संगठन

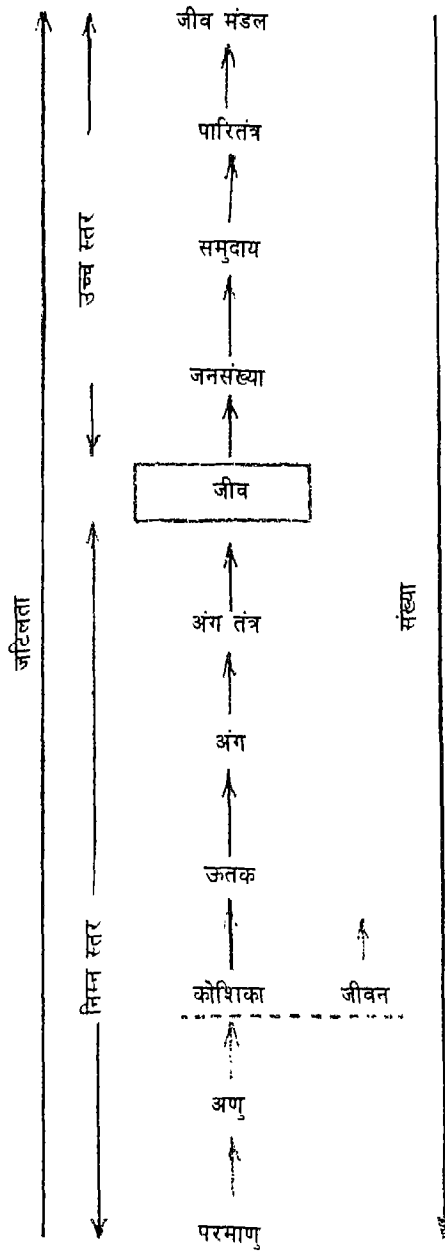
भूमिका

हमारे चारों ओर सरल तथा जटिल जीव हैं। पौधों में जड़, तना, पत्तियाँ तथा फल होते हैं। जन्तुओं में हाथ-पैर, आंखें, कान तथा अन्य अंग होते हैं। जीवों के आंतरिक तथा बाह्य अंग उन्हें संरचनात्मक तथा क्रियात्मक गुण प्रदान करते हैं। हम जीव की तुलना किसी भी मशीन से कर सकते हैं जिसका उपयोग विभिन्न कार्यों के लिए होता है। प्रत्येक अंग या भाग एक विशेष कार्य करता है और अंगों का समूह विभिन्न कार्य करता है। जीव तथा मशीन दोनों में ही संपूर्ण संरचना तथा समन्वयित कार्य एक संगठन का रूप देता है। यह संरचना तथा कार्य दोनों में ही प्रकट होता है।

आइये हम किसी जीव की तुलना किसी मशीन से करके देखें। सभी जीव पोषण प्रक्रिया द्वारा भोजन बनाते अथवा लेते हैं तथा इस भोजन से श्वसन प्रक्रिया द्वारा ऊर्जा प्राप्त करते हैं। इस ऊर्जा का उपयोग नये पदार्थों के बनने में होता है जिससे जीवों में वृद्धि होती है। इस पूरी प्रक्रिया को **उपापचय** (metabolism) कहते हैं। ये उपापचयी क्रियाएं जीवों की संतति बनाए रखने के लिए जनन में सहायता करती हैं।

आप देख सकते हैं कि जीव तथा मशीन दोनों में ही संरचनात्मक संगठन होता है जो समन्वयित कार्य करने में सहायता करता है। संरचना को देखकर आप उसकी जटिलता का अनुमान लगा सकते हो। कुछ जीव एक-कोशिकीय होते हैं। ऐसे जीवों जैसे **अमीबा, पैरामीशियम** में एक ही कोशिका सभी कार्य करती है। लेकिन बहु-कोशिकीय जटिल जीवों जैसे मनुष्य, जानवर तथा वृक्षों में विशेष कार्यों के लिए विशेष अंग होते हैं। सजीव जगत के जीवों में संरचनात्मक तथा क्रियात्मक संगठन होता है। जीवों के इस संगठन को हम विभिन्न स्तरों पर देख सकते हैं।

17.1 संगठन के स्तर

संगठन के विभिन्न स्तरों के अध्ययन के लिये किसी जीव को प्रारम्भिक स्तर मान सकते हैं। इस स्तर को **जैविक स्तर** कहते हैं। यह जीव किसी भी प्रकार का पौधा या जानवर हो सकता है। कुछ सामान्य नियमों के आधार पर सरल से जटिल संगठन के स्तर बनाये जा सकते हैं (चित्र 17.1)। इस प्रकार संगठन के स्तरों को उच्च स्तर तथा निम्न स्तर दो वर्गों में बांटा जा सकता है।

चित्र 17.1 सजीव जगत में संगठन के विभिन्न स्तर।

उच्च स्तर

आप सभी **होमोसेपिएन्स** (Homo sapiens) नामक एक विशेष जाति के जीव हैं। इसी प्रकार आपके कुटुम्ब के सभी सदस्य, पास-पड़ोस, कस्बे, प्राँत, देश-प्रदेश और संसार के सभी मनुष्य होमोसेपिएन्स जाति के सदस्य हैं। किसी विशेष जाति के समूह को **आबादी** (Population) कहते हैं। आबादी संगठन के पदानुक्रम में दूसरा स्तर है।

क्रियाकलाप – 1

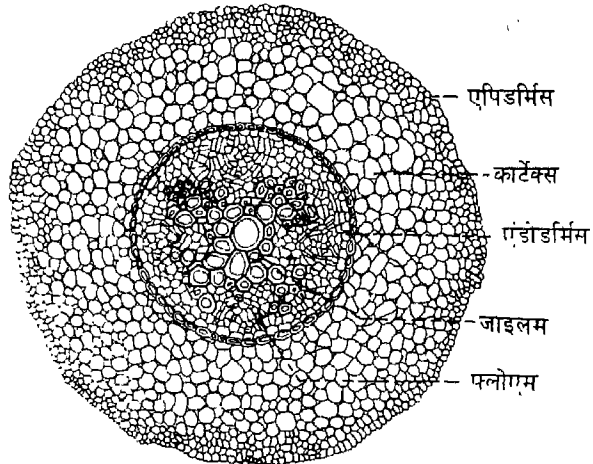
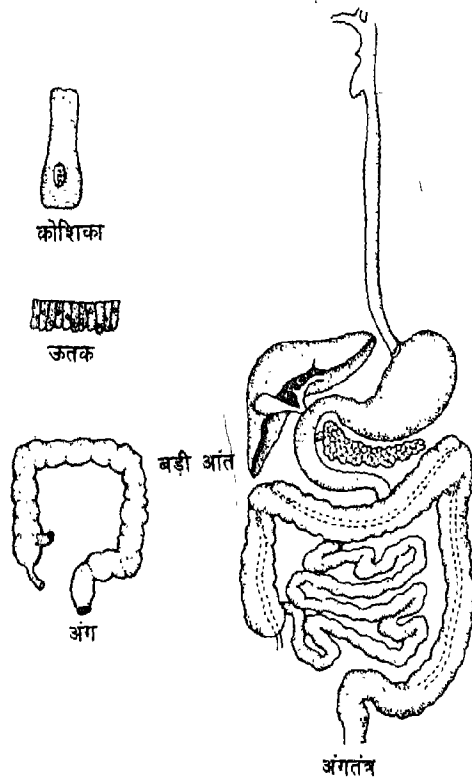
अपने आस-पास के विभिन्न पौधों तथा जंतुओं को देखिये। इन जीवों की जनसंख्या लिखिये। इनका पौधों तथा जन्तुओं की आबादी में वर्गीकरण करिए। जंतुओं की आबादियों को पक्षी, सरीसृप, स्तनधारी आदि में वर्गीकृत किया जा सकता है। आप पौधों तथा जंतुओं की आबादी को विद्यालय, बागों तथा खेतों में देख सकते हैं। किसी आबादी के सभी जीव आकृति में एक दूसरे से मिलते-जुलते हैं तथा उनमें बहुत ही कम अंतर होता है। किसी आबादी का दूसरा गुण यह है कि इसके जीवों में संकरण (interbreeding) होता है जिससे कि वे अपने समान जीव उत्पन्न कर सकते हैं। आइये, अब हम एक गेहूं के खेत का उदाहरण लें। गेहूं के खेत में अन्य दूसरी किस्म के पौधे भी उगे होते हैं जिन्हें खर-पतवार (weed) कहते हैं। खेत में आपको कुछ कीट तथा पक्षी भी दिखाई देंगे। खेत में पाई जाने वाली विभिन्न जातियों की आबादियाँ मिलकर **जैव समुदाय** (biotic community) बनाती है। जैव समुदाय संगठन का तीसरा स्तर है। किसी भी क्षेत्र की

पादप तथा जन्तु समुदाय की पहचान आबादी को देखने से हो सकती है। समुदाय का शब्द सामाजिक-विज्ञान में भी प्रयोग होता है । कभी-कभी हम मनुष्यों को विद्यार्थी समुदाय, वैज्ञानिक समुदाय आदि में भी वर्गीकृत करते हैं। यह वर्गीकरण उनके कार्य की प्रकृति पर आधारित होता है।

पहाड़ों, वनों, मरुस्थलों, तालाबों, झीलों तथा अन्य वास-स्थानों जैसे भौगोलिक क्षेत्रों में पाये जाने वाले जैव-समुदायों पर उन स्थानों के भौतिक वातावरण का प्रभाव होता है। किसी स्थान के निर्जीव तथा सजीव दोनों ही कारक संगठन के चौथे स्तर को बनाते हैं। इस स्तर को **पारितंत्र** (Ecosystem) कहते हैं। आप अपने आस-पास भी विभिन्न प्रकार के वासस्थानों को देख सकते हो जो पारितंत्र बनाते हैं। पारितंत्र बहुत छोटा भी हो सकता है जैसे जल-जीवशाला तथा तालाब या बहुत बड़ा हो सकता है जैसे वन। जब हम संसार के भौगोलिक क्षेत्रों के सभी छोटे-बड़े पारितंत्रों को एक समूह में देखते हैं तब हमें संगठन का अगला अर्थात् पांचवा स्तर मिलता है जिसे **जैव-मण्डल** (Biosphere) कहते हैं। सजीवों के संगठन में यह सर्वोच्च स्तर है। यह ब्रहमाण्ड का वह भाग है जो जीवन के लिए आवश्यक है।

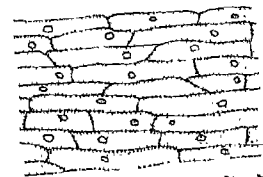
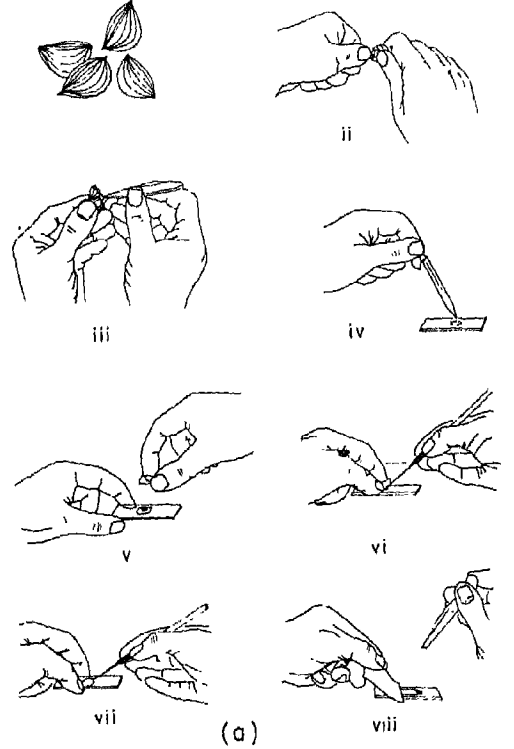
निम्नस्तर

उच्च स्तर के संगठन के अध्ययन के लिए हमने एक जीव को प्रारंभिक स्तर माना था। जीव के इसी स्तर को हम निम्न स्तर के संगठनों का अध्ययन करने के लिए भी प्रयोग कर सकते हैं। प्रत्येक जीव में एक पूर्ण विकसित संरचना होती है। इस संरचना में बहुत से छोटे-छोटे अंग होते हैं। ये अंग विभिन्न कार्य जैसे—भोजन निर्माण, भोजन का लेना, पाचन, अवशोषण तथा स्वांगीकरण करते हैं। प्रत्येक कार्य अलग-अलग भागों द्वारा सम्पन्न होता है जिसे सामूहिक रूप में पाचन क्रिया कहते हैं। इस प्रत्येक भाग को **अंग** (Organ) कहते हैं। ग्रीक भाषा में 'आर्गेन' का अर्थ होता है 'औजार'। मुंह, आमाशय, आंत तथा यकृत सभी अंग मिलकर पाचन तंत्र बनाते हैं। अंगों तथा उनके द्वारा किए समन्वित कार्य **अंग तंत्र** (Organ System) का निर्माण करते हैं। जीवों में अन्य कार्यों जैसे परिसंचरण, श्वसन तथा जनन करने के लिए विशेष अंग होते हैं। इसी प्रकार पौधे के विभिन्न अंग जैसे जड़, तना तथा पत्तियाँ भिन्न-भिन्न कार्य करते हैं।

प्रत्येक अंग में कई छोटे-छोटे भाग होते हैं। इन भागों को **ऊतक** (Tissue) कहते हैं। विभिन्न कार्यों को करने के लिए ऊतक अपने अंगों का एक विशेष कार्य करते हैं। हम इसे

चित्र 17.2 पादप ऊतक का सूक्ष्मदर्शी चित्र।

चित्र 17.3 मनुष्य की आंत में कोशिका, ऊतक, अंग तथा अंगतंत्र के स्तर।

समझाने के लिए पौधे का उदाहरण ले सकते हैं। यदि हम किसी पौधे की जड़ या तने की अनुप्रस्थ काट लें और उसे किसी रंग में रंगकर सूक्ष्मदर्शी से देखें तो हमें विभिन्न क्षेत्र दिखाई पड़ेंगे। चित्र 17.2 में इन क्षेत्रों को दिखाया गया है। ये क्षेत्र ऊतक को प्रदर्शित करते हैं। चित्र 17.3 में मनुष्य के पदानुक्रम स्तरों को दिखाया गया है।

क्रियाकलाप – 2

एक प्याज लीजिए तथा उसके छिलके से एक झिल्ली निकालिए। किसी स्लाईड पर पानी की

चित्र 17.4 (a) प्याज की झिल्ली की सूक्ष्मदर्शी स्लाइड तैयार करने की विधि।

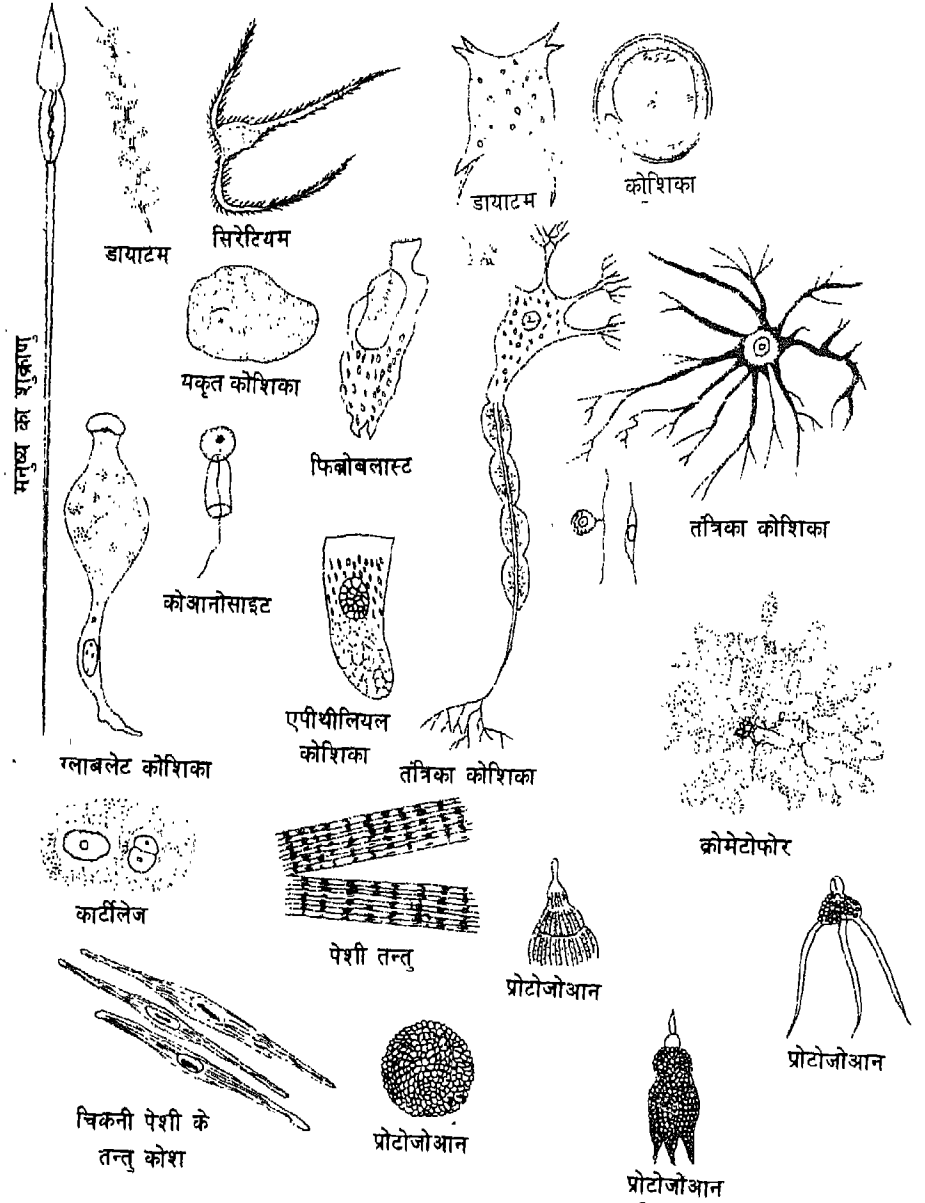
चित्र 17.4 (b) प्याज की झिल्ली की कोशिकाएं।

बूंद लेकर उस पर इस झिल्ली को रखिये। ड्रॉपर की सहायता से एक बूंद सैफ्रानिन डालिए। इसे बारी-बारी से कम शक्ति तथा उच्च शक्ति वाले सूक्ष्मदर्शी से देखिये। उच्च शक्ति के सूक्ष्मदर्शी से देखने के लिए कवरस्लिप का प्रयोग आवश्यक है। सूक्ष्मदर्शी से देखने पर आपको ईंट की तरह की संरचनाएं आपस में जुड़ी हुई दिखाई देंगी (चित्र 17.4)। ईंट जैसी दिखने वाली संरचना को **कोशिका** (Cell) कहते हैं। ऊतक में पाये जाने वाली सभी कोशिकाएं एक ही प्रकार का कार्य करती हैं। संगठन के इस स्तर को **कोशिकीय स्तर** (Cellular Level) कहते हैं। क्या इन कोशिकाओं में और भी छोटी इकाईयाँ होती हैं? इसका उत्तर हाँ है। ये छोटी इकाईयां अणु हैं। इसे संगठन का **आण्विक स्तर** (Molecular Level) कहते हैं जो निर्जीव है। इस प्रकार सजीवों में कोशिका सबसे निम्न स्तर है।

17.2 संगठन का सामान्य आधार

जीवों में संगठन के विभिन्न स्तरों में संरचनात्मक तथा क्रियात्मक स्तर होते हैं। जीवों के संगठन के विभिन्न स्तर निम्नलिखित सामान्य नियमों पर आधारित हैं·

1. प्रत्येक स्तर पर इकाईयाँ संगठित होती हैं जिसके कारण जीव का अगला स्तर बनता है। उदाहरण के लिये विभिन्न प्रकार के अणुओं की पारस्परिक क्रिया से कोशिका बनती है। कोशिकाएं विशेष प्रकार से संगठित होकर विभिन्न प्रकार के ऊतक बनाती हैं।
2. जैसे-जैसे संगठन का स्तर बढ़ता जाता है वैसे-वैसे ही उनकी संरचना तथा क्रियाएं जटिल होती जाती हैं।
3. संगठन के प्रत्येक स्तर पर कुछ सीमा तक काम करने की स्वतंत्रता होती है। यद्यपि जब ये संरचनाएँ या क्रियाएं किसी संगठन के अगले स्तर का भाग बन जाती हैं तब इनकी क्रियाओं पर कुछ अंकुश लग जाता है। उदाहरणतः किसी भी आबादी (Population) का कोई जीव अपने ढंग से जीने के लिए स्वतंत्र होता है लेकिन फिर भी उसे समुदाय के कुछ नियमों का पालन करना पड़ता है।
4. अवयवों में पारस्परिक क्रिया के इन नियमों अथवा सिद्धांतों के कारण जीवों में कुछ विशेष प्रकार के गुण तथा कार्य प्रकट होते हैं। इन नियमों की अनुपस्थिति में सभी चीजें अव्यवस्थित होती। सामूहिक तथा पारस्परिक क्रिया के कारण संगठन का उच्च स्तर बनता है।
5. प्रत्येक स्तर में कुछ ऐसे विशेष गुण होते हैं जो उसकी संगठनात्मक संरचना को दर्शाते हैं। ये गुण उन अंगों के अपने गुणों के अतिरिक्त होते हैं। उदाहरणतः हृदय एक ऐसा अंग है जो रुधिर को पम्प करने का विशेष कार्य करता है। लेकिन फिर भी इसके ऊतकों तथा पेशीय कोशिकाओं के अपने-अपने गुण भी होते हैं।
6. इस प्रकार प्रत्येक स्तर मिलकर अगले स्तर की जटिलता को बढ़ाते हैं। यदि हम अणु स्तर से जैव मण्डल स्तर तक देखें तो संरचना तथा कार्य में जटिलता बढ़ती जाती है।

7. उच्च स्तर पर खण्डन होने से भी उसके कारकों पर प्रभाव नहीं पड़ता।

चित्र 17.5 विभिन्न प्रकार की कोशिकाओं के कुछ उदाहरण।

उदाहरणतः किसी आबादी में बिखराव आने पर भी एक जीव अपने आप में भी जीवित रहता है।

8. अणु स्तर एवं इसके नीचे के स्तर अजैव अर्थात् निर्जीव हैं। कोशिकीय एवम् इसके ऊपर के स्तर सजीव जगत को बनाते हैं।

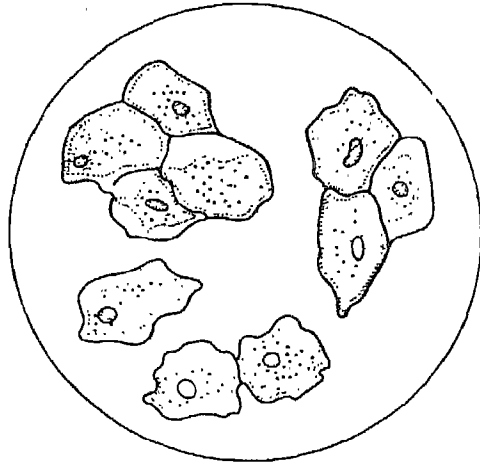
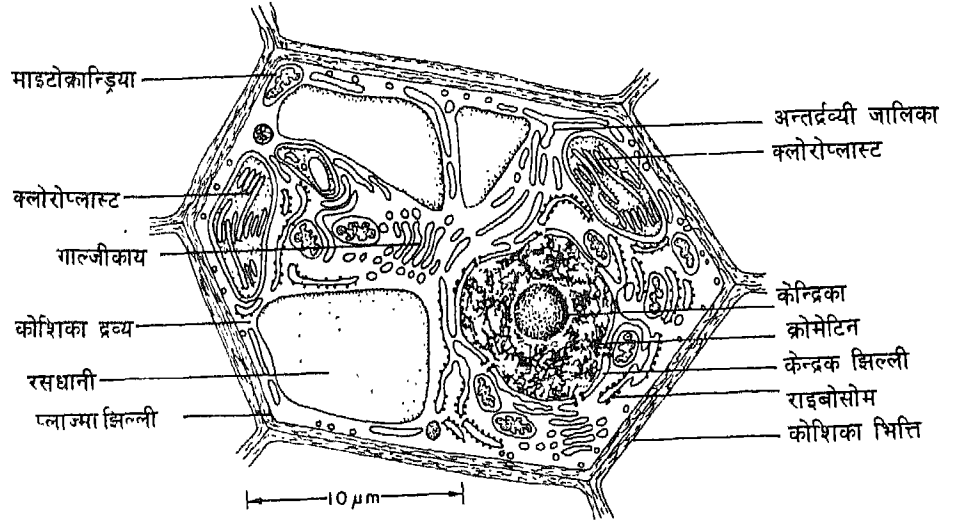
17.3 कोशिका संरचना

सजीव जगत में सबसे महत्वपूर्ण तथा मूल स्तर कोशिकीय स्तर है। कोशिकाएं जीवन की संरचनात्मक तथा क्रियात्मक इकाई हैं।

चित्र 17.5 में यह दिखाया गया है कि सजीवों की कोशिकाओं की आकृति, माप तथा संख्याएं परस्पर भिन्न होती हैं। कोशिका की माप 0.1 माइक्रो मीटर (जैसे **प्लूरोनिमोनिया** में) से लेकर 170×135 मिली मीटर (जैसे शुर्तुमुर्ग का अण्डा) तक हो सकती है। कोशिका की माप कोशिका के कार्य पर निर्भर करती है। उदाहरणतः कुछ तन्त्रिका कोशिकाएं एक मीटर से भी अधिक लम्बी होती हैं।

कोशिकाओं की विभिन्न आकृतियां होती हैं। कुछ एक कोशिकीय जीव जैसे **अमीबा** अपने आकार को लगातार बदलते रहते हैं। हमारे रुधिर की श्वेत रक्त कोशिकाएं भी अपनी आकृति बदलती रहती हैं। कोशिका की आकृति भी कोशिका के कार्य से संबंधित होती है। तंत्रिका कोशिका इस संबंध को प्रदर्शित करती है। तंत्रिका कोशिका एक लम्बी पतली तार की तरह होती है क्योंकि इसे शरीर के विभिन्न भागों में संदेश पहुँचाना पड़ता है। किसी जीव में कोशिकाओं की संख्या समय-समय पर बदलती रहती है। कोशिकाओं की संख्या भिन्न-भिन्न जीवों में अलग-अलग होती है। हाथी की कोशिकाओं की संख्या निश्चित रूप से चूहे की अपेक्षा अधिक होगी। क्या आप सोचते हैं कि कोशिकाओं की संख्या पौधों में भी बदलती रहती है? किसी वृक्ष तथा गुलाब के पौधे के विषय में सोचिए।

क्रियाकलाप—3

मुँह के अंदर से गाल की खाल को किसी साफ तीली से खुँरचिये। इस खुरचन को किसी स्लाईड पर रखिये। इस पर एक बूंद पानी डालिये। सुई की सहायता से इसे फैलाइये। फिर इसके ऊपर 0.5% जैनस ग्रीन की एक बूंद डालिये और इसे दो मिनट के लिए छोड़ दीजिये। इसके ऊपर कवरस्लिप रखकर इसे निम्न तथा अधिक शक्ति वाले सूक्ष्मदर्शी से बारी-बारी से देखिये और उसका चित्र बनाइये।

चित्र 17.6 गाल की कोशिकाओं का सूक्ष्मदर्शी चित्र।

चित्र 17.7 पादप-कोशिका की भीतरी रचना।

चित्र 17.7 में कोशिका के मूल अवयवों को दिखाया गया है। यहां पर हमने एक पादप कोशिका को दिखाया है क्योंकि इसमें जन्तु कोशिका से कुछ अधिक अवयव होते हैं। कोशिका के अवयव एक झिल्ली द्वारा घिरे रहते हैं जिसे **प्लाज़्मा झिल्ली** (Plasma membrane) कहते हैं।

ये झिल्ली पदार्थों के भीतर आने या बाहर जाने पर नियन्त्रण रखती है। प्लाज़्मा झिल्ली के बाहर पादप कोशिका में एक और परत होती है जिसे **कोशिका भित्ति** (Cell wall) कहते हैं। कोशिका भित्ति पादप कोशिका को निश्चित आकार तथा आकृति बनाये रखने में सहायक होती है। कोशिका के अंदर के तरल माध्यम को **कोशिका द्रव्य** (Cytoplasm) कहते हैं। कोशिका द्रव्य एक पारभासी चिपचिपा पदार्थ होता है जिसमें और भी बहुत सी संरचनाएं होती हैं। प्रत्येक संरचना को **अंगक** (organelle) कहते हैं।

कोशिका के मध्य में एक **केन्द्रक** (nucleus) होता है। केन्द्रक के चारों ओर अपनी एक झिल्ली होती है। केन्द्रक में **केन्द्रिकाएँ** (Nucleolie) तथा **क्रोमेटिन** (Chromatin) होते हैं। कोशिका विभाजन के समय क्रोमेटिन **क्रोमोसोम** में रूपान्तरित हो जाते हैं। क्रोमोसोम में वे सभी आवश्यक सूचनाएं होती हैं जो कोशिका के कार्य करने तथा अगली संतति के लिए जनन में आवश्यक होती है। क्रोमोसोम में बहुत से **जीन** होते हैं। प्रत्येक जीन जीव के एक आनुवंशिक गुण के लिए उत्तरदायी होता है। इसीलिए आनुवंशिक अध्ययन को **आनुवंशिकी** (genetics) कहते हैं।

केन्द्रक के बाहर जालिका रूपी संरचनाएं होती हैं जिन्हें **अंतर्द्रव्यी जालिका** (Endoplasmic reticulum) कहते हैं। कुछ जालिकाओं के किनारों पर **राईबोसोम** होते हैं जो कोशिका में प्रोटीन संश्लेषण का कार्य करते हैं। **क्लोरोप्लास्ट** केवल पादप कोशिकाओं में होता है (चित्र 17.7)। क्लोरोप्लास्ट में ही प्रकाश संश्लेषण होता है। जन्तु कोशिकाओं में क्लोरोप्लास्ट नहीं होते हैं।

कोशिका के महत्वपूर्ण अंगकों में **माइटोकॉन्ड्रिया** (Mitrochondria) भी एक अंगक है। एक कोशिका में बहुत से माइटोकॉन्ड्रिया होते हैं। माइटोकॉन्ड्रिया में भोजन का संपूर्ण ऑक्सीकरण होता है जिससे कोशिका को बहुत अधिक मात्रा में ऊर्जा प्राप्त होती है। इसी कारण माइटोकॉन्ड्रिया को कोशिका का पावर हाउस कहते हैं। **गाल्जीकाय** (Golgi apparatus)-चपटी झिल्लियों की एक संरचना होती है। इसमें कोशिका से स्रावित होने वाले पदार्थों पर प्रक्रिया होती है। ये स्रावित पदार्थ **रसधानियों** (Vacuoles) में आ जाते हैं। रसधानियों में प्रायः कोशिका-रस, लवण, शक्कर तथा पानी में घुले हुए बहुत से वर्णक (pigments) होते हैं। ये रसधानियाँ जन्तु कोशिका की अपेक्षा पादप कोशिका में अधिक होती हैं। जन्तु कोशिका पादप कोशिकाओं से कई प्रकार से भिन्न होती है। पादप कोशिकाओं में कोशिका भित्ती होती है जो सेल्यूलोज की बनी होती है किन्तु जन्तु कोशिका में ऐसी कोई भित्ती तथा सेल्यूलोज नहीं होता। पादप कोशिका में क्लोरोप्लास्ट होता है जबकि जन्तु कोशिका में नहीं होता। पादप कोशिकाओं में बड़ी-बड़ी रसधानियां होती हैं जो कोशिका का काफी भाग घेरे रहती हैं। फलस्वरूप कोशिका-द्रव्य प्लाज़्मा झिल्ली के साथ-साथ छोटे से भाग में ही दिखाई देता है परन्तु जन्तु कोशिका में या तो रसधानियां होती ही नहीं, अगर होती हैं तो बहुत छोटी। अतः कोशिका द्रव्य समान रूप से कोशिका में वितरित रहता है। जन्तु कोशिकाओं तथा जीवाणु कोशिकाओं की सतह पर कुछ बारीक संरचनाएं जिन्हें **सिलिया** (Cilia) कहते हैं अथवा लम्बे हन्टर की तरह की संरचनाएं जिन्हें **कशाभिका** (Flagella) कहते हैं, पाई जाती हैं। ये संरचनाएं गमन में सहायता करती हैं (चित्र 17.5)।

इस प्रकार हम देखते हैं कि किसी कोशिका के प्रत्येक अंगक विशेष कार्य करते हैं। ये सब संगठित होकर एक सजीव इकाई बनाते हैं जिसे कोशिका कहते हैं।

सजीवों का एक महत्वपूर्ण गुण यह है कि उनमें जनन की क्षमता होती है और कोशिकाएं ही ये कार्य करती हैं। कोशिकायें विभाजन की प्रक्रिया द्वारा नई कोशिकायें बनाती हैं। अधिकतर सभी कोशिकाओं में विभाजन एवं वृद्धि की क्षमता होनी है। कोशिका विभाजन के समय केन्द्रक भी दो भागों में बंट जाता है और प्रत्येक कोशिका में एक केन्द्रक चला जाता है। प्रत्येक केन्द्रक में क्रोमोसोम की संख्या निश्चित होती है। कोशिका विभाजन से पहले प्रत्येक क्रोमोसोम से दो समान क्रोमोसोम बन जाते हैं, जिससे केन्द्रक में क्रोमोसोम की संख्या दोगुनी हो जाती है। केन्द्रक विभाजन के समय क्रोमोसोम का एक जोड़ा संतति कोशिका (daughter cell) में चला जाता है। इस प्रकार दोनों संतति कोशिकाओं में क्रोमोसोम

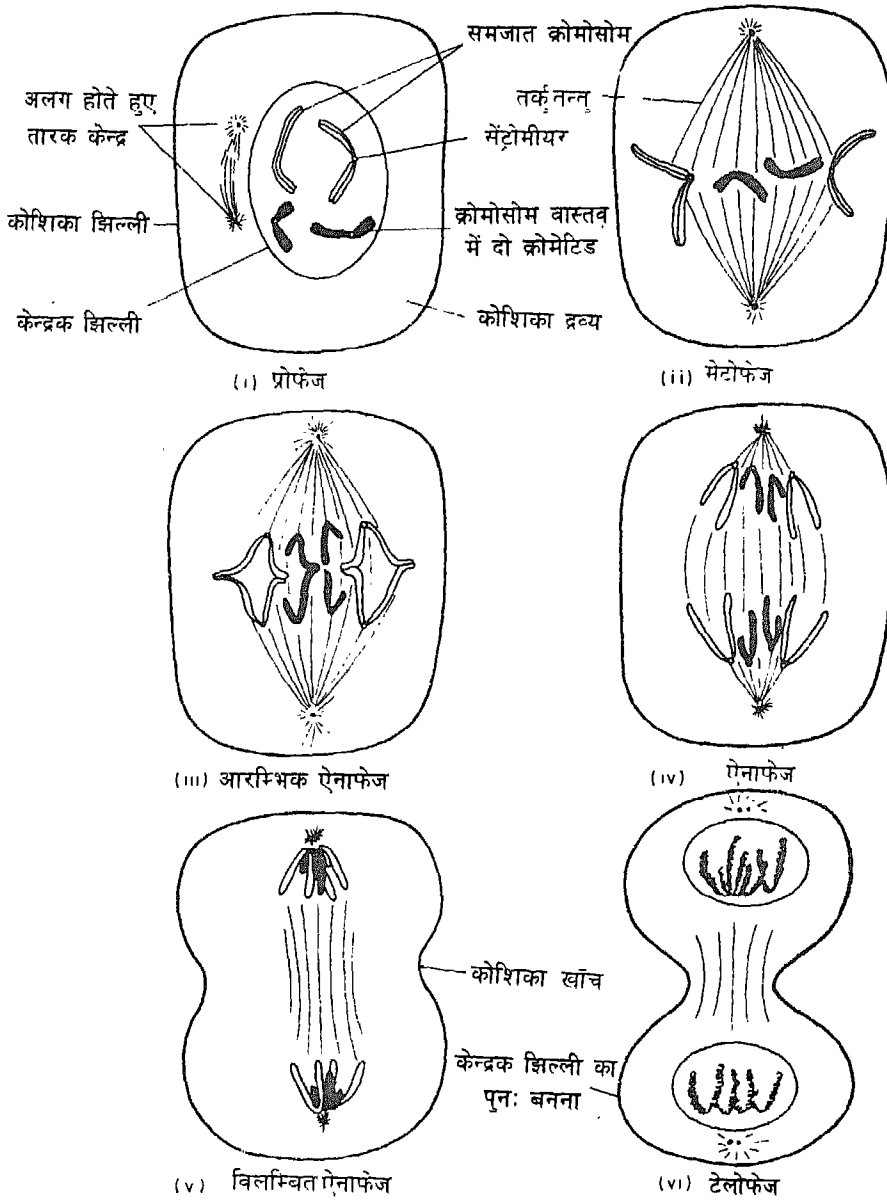
की संख्या बराबर होती है और उनमें प्रत्येक क्रोमोसोम के गुण भी समान होते हैं।

17.4 माइटोसिस (Mitosis) तथा मिऑसिस (Meiosis)–कोशिका विभाजन की दो विधियाँ

1877 में जर्मनी के जीव वैज्ञानिक वाल्थर फ्लैमिंग ने कोशिका विभाजन की प्रक्रिया को देखा। उन्होंने इस प्रक्रिया को **माइटोसिस** (सम सूत्री विभाजन) का नाम दिया। माइटोसिस का अर्थ है धागों का बनना। यह विवरण केन्द्रक विभाजन के संदर्भ में है जिसमें क्रोमोसोम धागों की तरह होते हैं। सम सूत्री कोशिका विभाजन सभी एक कोशिकीय जीवों में होता है। बहु कोशिकीय जीवों में माइटोसिस द्वारा कोशिकाओं की संख्या में वृद्धि होती है जिसके कारण जीव की वृद्धि तथा उसका विकास होता है।

माइटोसिस

माइटोसिस पांच अवस्थाओं में पूरा होता है। विभाजन से पहले केन्द्रक बड़ा हो जाता है और उसमें क्रोमोसोम धागे की तरह की संरचनाओं के रूप में दिखाई देने शुरू हो जाते हैं। क्रोमोसोम की संख्या दोगुनी हो जाती है। इस अवस्था को **अन्तरावस्था** (Interphase) कहते हैं। कोशिका विभाजन प्रोफेज़ से शुरू होता है (चित्र 17.8)। इस अवस्था में क्रोमोसोम मोटे और छोटे हो जाते हैं और केन्द्रक झिल्ली लुप्त हो जाती है। प्रत्येक क्रोमोसोम स्पष्ट रूप से दो भाग में दिखाई देते हैं जिन्हें क्रोमेटिड कहते हैं। ये क्रोमेटिड आपस में **सेन्ट्रोमीयर** द्वारा जुड़े रहते हैं। प्रत्येक क्रोमेटिड एक क्रोमोसोम बन जाता है। **प्रोफेज** अवस्था में दो छोटे पिण्ड भी होते हैं जिन्हें **तारककेन्द्र** (Centrioles) कहते हैं। तारककेन्द्र कोशिका के दोनों ओर जाना आरम्भ कर देते हैं। अगली अवस्था **मेटाफेज** में तारककेन्द्र से बहुत से तन्तु निकलते हैं जो क्रोमोसोम के सेन्ट्रोमीयर से जुड़ जाते हैं। इसे **तर्कु** (spindle) तन्तु कहते हैं। प्रत्येक क्रोमोसोम से इस अवस्था में दो क्रोमेटिड अलग होना आरम्भ कर देते हैं जो **ऐनाफेज** अवस्था में पूर्ण रूप से अलग हो जाते हैं। जैसा हमने पहले बताया कि क्रोमेटिड क्रोमोसोम की ही **प्रतिलिपि** (कापी) होते हैं। प्रतिलिपि बनने की प्रक्रिया अन्तरावस्था में ही आरम्भ हो जाती है लेकिन मेटाफेज में बहुत ही स्पष्ट हो जाती है। ऐनाफेज की बाद की अवस्था में कोशिका के बीच में एक खांच बन जाती है और क्रोमेटिड विपरीत ध्रुवों पर एकत्रित हो जाते हैं। कोशिका विभाजन की अंतिम अवस्था **टेलोफेज़** (अंत्यावस्था) होती है जिसमें क्रोमेटिड से क्रोमोसोम बन जाते हैं और वह दो सिरों पर चले जाते हैं। केन्द्रक झिल्ली पुनः बन जाती है और दो केन्द्रकों को अलग-अलग कर देती है। जन्तु कोशिकाओं में कोशिका खांच बनती है और अंततः दो भागों में विभक्त हो जाती है। पादप कोशिका में खांच नहीं बनती बल्कि कोशिका के बीचों बीच एक नई कोशिका भित्ति बनती है जो दोनों कोशिकाओं को अलग कर देती है।

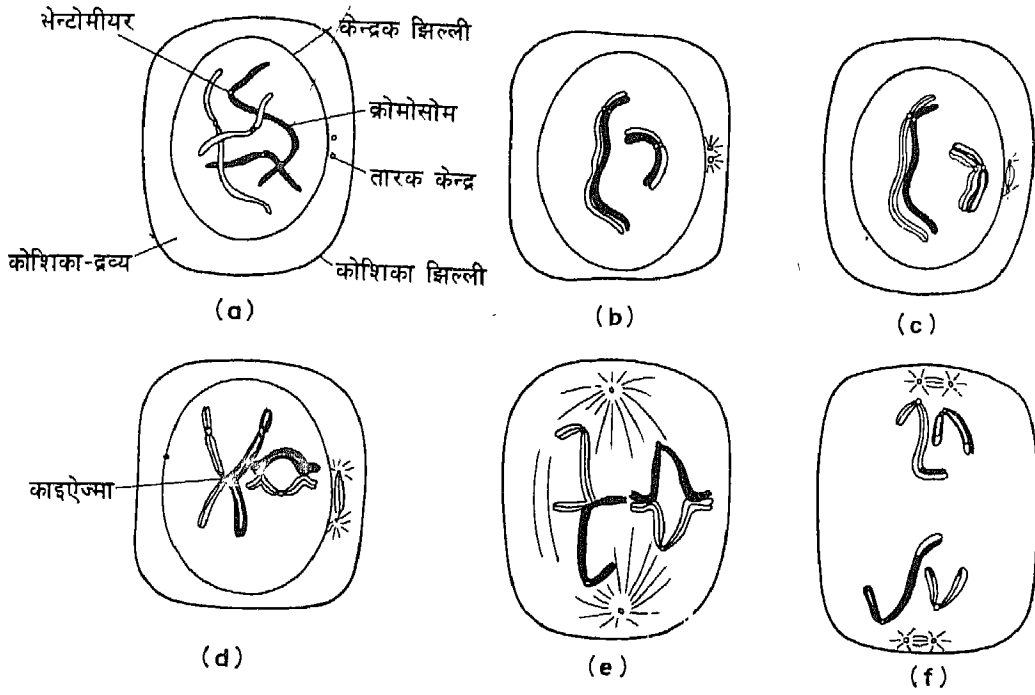
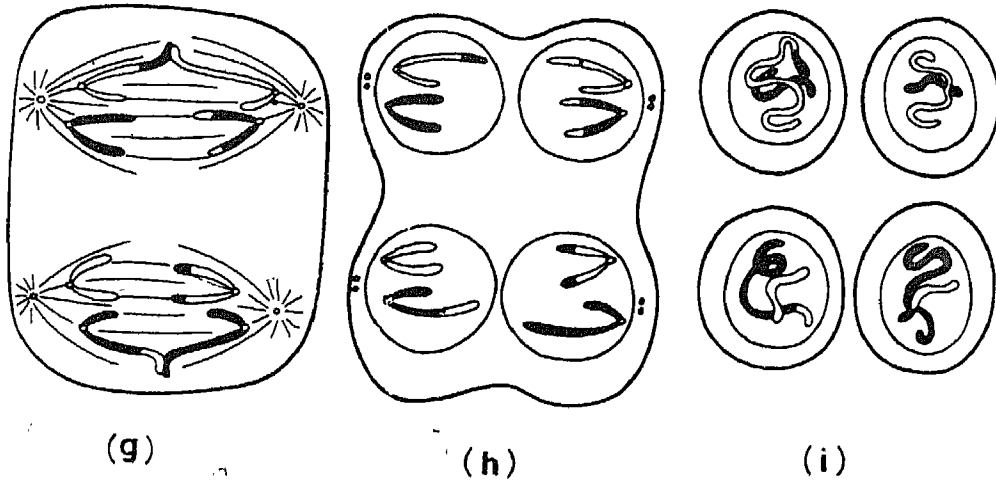
इस प्रकार हम देखते हैं कोशिका विभाजन की प्रक्रिया में क्रोमोसोम कोशिका का एक महत्वपूर्ण

चित्र 17.8 माइटोटिक विभाजन की विभिन्न अवस्थाएं।

अंग है। ये कोशिका विभाजन के समय ही स्पष्ट रूप से दिखाई देते हैं। विराम अवस्था में अर्थात् जब कोशिका में विभाजन नहीं हो रहा होता, क्रोमोसोम केन्द्रक में बहुत पास-पास संकुलित रहते हैं जिसे कोमेटिन कहते हैं। प्रत्येक स्पीशीज की कोशिका में क्रोमोसोम की संख्या निश्चित होती है। चूहे की कोशिका में क्रोमोसोम की संख्या 40, आलू में 48, कुत्ते में 64 तथा मनुष्य में 46 होती है। ये क्रोमोसोम दो-दो के जोड़ों में होते हैं और इनकी लम्बाई तथा आकार निश्चित होता है। इनकी लंबाई तथा आकार सेन्ट्रोमीयर के स्थान द्वारा निश्चित होते हैं। एक जोड़े के प्रत्येक सदस्य को **होमोलोगस** (समलिंगी) क्रोमोसोम कहते हैं। प्रत्येक कोशिका में क्रोमोसोम की कुल संख्या द्विगुणित संख्या (**डिप्लॉइड संख्या**) में होती है। इस प्रकार मनुष्य के शरीर में 46 **डिप्लॉइड** होमोलोगस क्रोमोसोम होते हैं। आप ज्यों-ज्यों बड़े होते हैं आपके शरीर में माइटोसिस द्वारा कोशिकाओं की संख्या तो बढ़ती रहती है लेकिन प्रत्येक कोशिका के केन्द्र में 46 क्रोमोसोम होते हैं।

मिऑसिस

माइटोसिस प्रक्रिया का महत्वपूर्ण अपवाद लैंगिक जनन है। इसमें कुछ विशेष कोशिकाएं भाग लेती हैं जिन्हें शुक्राणु कोशिका तथा अण्ड कोशिका कहते हैं। ये कोशिकाएं पादप तथा जन्तु जगत दोनों में ही होती हैं। मनुष्य में 46 क्रोमोसोम वाली कोशिका बनाने के बजाए यह प्रक्रिया 23 क्रोमोसोम वाले **युग्मक** (gametes) बनाती है। युग्मक नर तथा मादा की लैंगिक कोशिकाओं में बनते हैं तथा इनमें क्रोमोसोम की संख्या आधी होती है। इस प्रकार युग्मक डिप्लॉइड न होकर अगुणित (**हैप्लॉयड**) होते हैं। युग्मक में दो की बजाए क्रोमोसोम का एक ही सेट होता है। **निषेचन** प्रक्रिया में नर तथा मादा युग्मक मिलकर **युग्मनज** (Zygote) बनाते हैं। युग्मनज डिप्लॉइड होता है और इसमें उस स्पीशीज के पूरे क्रोमोसोम (दो सेट) होते हैं। इसमें आधे क्रोमोसोम (एक सेट) माता से और आधे (दूसरे सेट) पिता से आते हैं।

मिऑसिस प्रक्रिया भी विभिन्न अवस्थाओं में होती है। एक डिप्लॉयड क्रोमोसोम (2N) वाली कोशिका प्रोफेज–1 से विभाजन की प्रक्रिया आरम्भ करती है। सूक्ष्मदर्शी से देखने पर क्रोमोसोम एक धागे की तरह दिखाई देते हैं। माइटोसिस प्रक्रिया के विपरीत जिसमें दोनों क्रोमोसोम एक-दूसरे से अलग हो जाते हैं, मिऑसिस में दोनों क्रोमोसोम एक दूसरे के पास आकर समलिंगी क्रोमोसोम के जोड़े बन जाते हैं जैसा कि चित्र 17.9c में दिखाया गया है।

प्रत्येक क्रोमोसोम के दो क्रोमेटिड दिखाई पड़ते हैं। **काइऐज्मा** वाले भाग के अतिरिक्त क्रोमेटिड के दो जोड़े अलग होने लगते हैं (चित्र 17.9d)। इस क्षेत्र (काइऐज्मा) में क्रोमैटिड वास्तव में अपने भागों का आदान-प्रदान (विनिमय) या क्रासिंग ओवर करते हैं। मेटाफेज अवस्था में एक तर्कु बन जाता है तथा होमोलोगस क्रोमोसोम के मध्य स्थल पर आ जाता है (चित्र 17.9e)। ऐनाफेज अवस्था में क्रोमोसोम विपरीत ध्रुवों पर चले जाते हैं तथा अपने साथ विनियम किये हुए भाग भी ले जाते हैं (चित्र 17.9f)। द्विगुणन तथा क्रोमेटिड के अलग होने के कारण इस अवस्था में कोशिका में N क्रोमोसोम होते हैं। प्रथम मिऑटिक विभाजन I

चित्र 17.9 मिऑटिक विभाजन की विभिन्न अवस्थाएं (b,e,f अवस्थाओं मे क्रोमोसोमों के भागों में आदान-प्रदान हो रहा है)। देखें कि मिऑटिक g अवस्था से आरम्भ होती है और i। अवस्था में चार युग्मक बनाकर समाप्त हो जाती है।

यहां समाप्त हो जाता है और दूसरा मिऑटिक विभाजन II आरम्भ हो जाता है। प्रोफेज अवस्था में एक तर्कु बनता है जो पहले विभाजन में बने तर्कु के लंबवत् होता है (चित्र 17.9g)। ऐनाफेज II में सेन्ट्रोमीयर विभक्त होते हैं और होमोलोगस क्रोमेटिड अलग हो जाते हैं। अंत में टेलोफेज अवस्था में एक केन्द्रक से चार केन्द्रक बन जाते हैं तथा प्रत्येक नए बने केन्द्रक में क्रोमोसोम की संख्या हैप्लॉयड (N) होती है (चित्र 17.9h)। केन्द्रक के चारों ओर केन्द्रकीय झिल्ली बन जाती है, कोशिका द्रव्य विभक्त होता है और मिऑसिस के अंत में चार युग्मक कोशिकाएं बन जाती हैं (चित्र 17.9i)। अगर इन कोशिकाओं को शुक्राणु बनना है तो इन चारों कोशिकाओं में ये पूँछ बन जाती है जिससे कि शुक्राणु गतिशील रह सकें।

मिऑसिस को **न्यूनकारी** (रिडक्शनल) **विभाजन** भी कहते हैं क्योंकि इससे क्रोमोसोम की डिप्लॉइड संख्या आधी रह जाती है। वास्तव में मिऑसिस में दो उप विभाजन होते हैं जैसा कि चित्र 17.9 में दिखाया गया है। तालिका 17.1 में माइटोसिस तथा मिऑसिस के गुणों में अंतर दिखाए गये हैं।

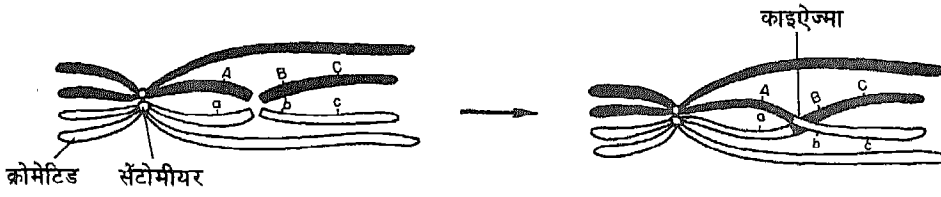
तालिका 17.1

माइटोसिस तथा मिऑसिस

माइटोसिस	मिऑसिस
1. सभी कोशिकाओं में होती है	1. केवल लैंगिक कोशिका में होती है।
2. क्रोमोसोम की संख्या में कोई परिवर्तन नहीं होता	2. क्रोमोसोम की संख्या आधी हो जाती है।
3. प्रक्रिया 5 अवस्थाओं में पूर्ण होती है।	3. दो उप विभाजनों में पूर्ण होती है प्रत्येक उपविभाजन में 4 या 5 अवस्थाएं होती हैं।
4. क्रोमोसोम के पदार्थों में आदान–प्रदान नहीं होता। संतति कोशिकाओं में भी उसी प्रकार के क्रोमोसोम होते हैं जैसे पैतृक कोशिका में होते हैं आनुवंशिकी संतति में कोई भी विविधता नहीं होती।	4. क्रोमोसोम में विनिमय होता है। संतति कोशिका में क्रोमोसोम पदार्थ का कुछ भाग पितृ कोशिका से तथा कुछ भाग मातृ कोशिका से आता है। संरचना में भी विविधता होती है।

17.5 विनिमय का महत्व

लैंगिक कोशिकाओं में विभाजन मिऑसिस द्वारा होता है। हमने चित्र 17.9 में देखा है कि किस प्रकार क्रोमेटिड काइऐज्मा क्षेत्र में क्रोमोसोम पदार्थों का आदान-प्रदान करते हैं।

जब होमोलोगस क्रोमोसोम के जोड़े बनते हैं तब माता-पिता के क्रोमेटिड जीन का आदान-प्रदान करते हैं। चित्र 17.10 में दिखाया गया है कि माता का क्रोमेटिड पिता के क्रोमेटिड से b तथा c जीन को ले लेता है। जबकि पिता के क्रोमेटिड उसके बदले

चित्र 17.10 मिऑसिस विभाजन के समय होमोलोगस क्रोमोसोम के क्रोमेटिडों में आदान-प्रदान होता है।

माता के क्रोमेटिड से B तथा C जीन ले लेता है। इस प्रकार जो क्रोमोसोम बना वह माता-पिता के क्रोमोसोम से भिन्न है। वास्तव में इसके कुछ गुण माता-पिता दोनों के होते हैं। इस प्रकार के क्रासिंग ओवर तथा क्रोमेटिड के आदान-प्रदान करने से युग्मकों की जीन संरचना में विविधता आ जाती है। उपरोक्त चुने हुए जीनों में एक युग्मक में जीन का क्रम Abc होगा तो दूसरे में ABC।

जीन क्रोमोसोम का एक भाग है और आनुवंशिक गुणों के लिए उत्तरदायी है। वे माता-पिता से संतति में आते हैं। माता-पिता के क्रोमोसोम में क्रासिग ओवर होने के कारण आप देख सकते हो कि उनकी संतान में कुछ गुण माता के होते हैं तो कुछ गुण पिता के। अब आप समझ सकते हैं कि एक ही माता-पिता के दो बच्चों में कितनी समानता होती है लेकिन फिर भी वे एक दूसरे से भिन्न होते हैं। युग्मक में जीन की संरचना में अंतर आने के कारण ऐसा होता है।

जुड़वां बच्चों में क्या होता है? उनके गुणों में कोई विविधता नहीं होती इसीलिए उन्हें जुडवां बच्चे (Identical twins) कहते हैं। कभी-कभी ऐसा होता है कि एक निषेचित अंडा कुछ समय विभाजन करने के बाद दो भ्रूणों (Embryos) में अलग हो जाता है। दोनों भ्रूणों में एकसमान क्रोमोसोम होंगे क्योंकि ये दोनों माइटोसिस विभाजन द्वारा बने हैं। इसी कारण दोनों जुड़वां बच्चों के विशेषक समान होंगे। दोनों जुड़वां बच्चों का लिंग भी समान होगा। ऐसी ही स्थिति तीन या अधिक बच्चे उत्पन्न होने पर होगी। यद्यपि मनुष्य में एक साथ दो या अधिक बच्चे पैदा यदा कदा ही उत्पन्न होते हैं।

जुड़वा बच्चे असमान (Fraternal twins) भी होते हैं। ऐसा तब होता है जब दो अलग-अलग अंडों का निषेचन दो अलग-अलग शुक्राणुओं से होता है। इस प्रकार बने दोनों युग्मनजों में क्रोमोसोम भी अलग प्रकार के होंगे तथा उनमें आनुवंशिक भिन्नता भी होगी। वे दोनों एक ही गर्भाशय में साथ-साथ वृद्धि करते हैं। इस प्रकार से उत्पन्न दोनों बच्चों के विशेषक, कभी-कभी लिंग तथा विकास आदि, सभी भिन्न होते हैं।

प्रश्नावली

1. अंतर बताइये:
   (अ) आबादी तथा समुदाय

(ब) पारितंत्र तथा जीव मंडल
(स) अंग तथा अंगक

2. "वस्तुओं" को संगठित करके उच्चस्तर बनाने पर नये-नये गुण बनते हैं। इस कथन की विवेचना, कोशिकाओं के संगठन से ऊतक बनने के उदाहरण को लेकर करें।
3. जीव मंडल स्तर पर संगठन के स्तर समाप्त हो जाते हैं। क्या आप इससे भी उच्च स्तर के विषय में सोच सकते हैं तथा उस उच्च स्तर में किस प्रकार के गुण होंगे?
4. पादप तथा जन्तु कोशिकाओं में 5 अंतर लिखिये।
5. अंतर बताइये।
   (अ) क्रोमेटिन, क्रोमोसोम तथा क्रोमेटिड
   (ब) तारककेन्द्र, सेन्ट्रोमीयर तथा काइऐज़्मा
   (स) हैप्लॉइड तथा डिप्लॉइड कोशिकाएं
6. निम्नलिखित अवययों के क्या कार्य हैं?
   (a) राइबोसोम
   (b) गाल्जीकॉय
   (c) माइटोकॉन्ड्रिया
   (d) रसधानी
   (e) पादप कोशिका भित्ति
   (f) क्रोमोसोम
   (g) क्लोरोप्लास्ट
   (h) तर्कु
   (i) न्यूक्लिओलस
   (j) प्लाज्मा झिल्ली
7. चित्रों द्वारा माइटोसिस की विभिन्न अवस्थाओं को दिखाइये।
8. मिऑसिस को रिडक्शनल विभाजन क्यों कहते हैं?
9. चित्रों द्वारा मिऑसिस की विभिन्न अवस्थाओं का स्पष्टीकरण कीजिये।
10. कोई "क्लोन" (clone) कोशिकाओं का वह समूह है अथवा जीव होता है जो केवल एक माता-पिता की संतति है और जिसमें सभी गुण उनके समान होते हैं।" इसके आधार पर निम्नलिखित प्रश्नों के उत्तर दें:–
    (अ) क्लोन का जनन लैंगिक है अथवा अलैंगिक?
    (ब) क्या हम किसी जन्तु को क्लोन जनन द्वारा प्राप्त कर सकते हैं?
    (स) क्या समान जुड़वां बच्चे क्लोन हैं?
11. निम्नलिखित में से किसमें माइटोसिस जनन होता है और किसमें मिऑसिस
    (अ) *एश्करिया कोलाई*
    (ब) *पैरामिशियम*
    (स) आम का वृक्ष
    (द) यीस्ट
    (इ) मेंढक।

जैव-प्रक्रियाएं – I

भूमिका

सभी जीवों की क्रियाकलापों में कुछ समानताएं हैं। वे भोजन करते हैं, उसे पचाते हैं, भोजन से ऊर्जा लेते हैं और अपशिष्ट पदार्थों को शरीर से बाहर निकालते हैं। वे इन्हीं क्रियाकलापों से अपने जीवन का संधारण करते हैं। इन सभी क्रियाकलापों के अध्ययन को शरीर क्रिया विज्ञान (PHYSIOLOGY) कहते हैं। इस अध्याय में हम जीवों के शरीर की क्रियात्मक क्रियाओं के विषय में पढ़ेंगे।

18.1 पोषण

सभी जीव हर समय कुछ न कुछ क्रियाएं करते रहते हैं। इसके लिए उन्हें ऊर्जा की आवश्यकता होती है। यह ऊर्जा उन्हें लिये हुए भोजन से प्राप्त होती है। विभिन्न प्रकार के जीव भोजन लेने के लिये विभिन्न विधियाँ अपनाते हैं। भोजन लेने की प्रक्रिया को **पोषण** कहते हैं। यह वह प्रक्रिया है जिसमें जीव भोजन लेते हैं ताकि वे उपापचयी क्रियाओं के लिए भोजन से ऊर्जा प्राप्त कर सकें। पोषण की मुख्यतः दो विधियाँ हैं। **स्वपोषण** (Autotrophic) तथा **परपोषण** (Heterotrophic)। स्वपोषी सजीव अपना भोजन सरल सामग्री से बनाते हैं। इस प्रकार स्वपोषी भोजन के उत्पादक हैं। सभी हरे पौधे स्वपोषी होते हैं। ये अपना भोजन बनाने के लिए कार्बन डाइऑक्साइड, पानी तथा खनिज लवण जैसी कच्ची सामग्री का उपयोग करते हैं। हरे पौधों में यह प्रक्रिया **प्रकाश संश्लेषण** द्वारा होती है। कुछ अन्य जीव जैसे हरित सल्फर जीवाणु पानी की अपेक्षा हाइड्रोजन को हाइड्रोजन सल्फाइड से लेते हैं।

परपोषण में जीव अपना भोजन दूसरे जीवों से लेते हैं अर्थात् ये अपना भोजन दूसरे जीवों को खाकर प्राप्त करते हैं। सभी जानवर तथा कुछ पौधे परपोषी हैं। आइये स्वपोषी तथा परपोषी में कुछ अन्तर देखें। स्वपोषी अपना भोजन सरल पदार्थों और अणुओं से बनाते हैं। अधिकांश परपोषी जटिल पदार्थों को भोजन के रूप में लेते हैं और इन्हें तोड़कर सरल पदार्थों में परिवर्तित कर देते हैं।

परपोषी अपना भोजन दो प्रकार से लेते हैं—1. मृत और क्षय शरीर से तथा 2. उन जीवों से जिन्हें मार कर खाते हैं। मृत तथा क्षय शरीर से भोजन प्राप्त करने वाली विधि को **मृतजीवी**

(Saprophytic) कहते हैं। एक मृतजीवी अपना भोजन सड़े गले पत्तों, पौधों तथा क्षयी पदार्थों से प्राप्त करता है। फंजाई, फफूंदी, यीस्ट, छत्रक और जीवाणु मृतजीवी हैं। ये जटिल कार्बोनिक अणुओं को सरल पदार्थों में तोड़ देते हैं। इन सरल पदार्थों का उपयोग पौधों द्वारा होता है।

पोषण की अन्य विधि को **परजीवी** (Parasitic) कहते हैं। परजीवी वे प्राणी हैं जो दूसरे प्राणियों पर आश्रित रहते हैं और उनसे अपना भोजन प्राप्त करते हैं। (पुरातत्व ग्रीक में अपनी चाटुकारी से मुफ्त में भोजन प्राप्त करने वाले प्राणी को परजीवी कहते थे।) रोगाणु जो मलेरिया फैलाते हैं, परजीवी का एक उदाहरण हैं। क्या आप और कुछ उदाहरण बता सकते हैं?

हमने अभी तक जीवाणु तथा फंजाई जैसे निम्न वर्गीय जीवों में पोषण के विषय में पढ़ा है। उच्च वर्गीय प्राणी जैसे पौधे, जानवर तथा मनुष्य के विषय में आप क्या जानते हैं? ये जीव **प्राणि-समभोजी** (Holozoic) के उदाहरण हैं, जो ठोस भोजन लेते हैं। इन छोटे या बड़े भोजन के टुकड़ों का अंतर्ग्रहण (Ingestion) करने की आवश्यकता होती है। इस अंतर्ग्राहित भोजन का शरीर में पाचन होता है। पाचन की इस प्रक्रिया से भोजन के जटिल पदार्थ सरलतम पदार्थों में अपघटित हो जाते हैं। रासायनिक अभिक्रिया की यह शृंखला बहुत से एन्जाइमों से उत्प्रेरित होती है। पाचन क्रिया से प्राप्त सरल पदार्थ शरीर की कोशिकाओं में अवशोषित हो जाते हैं और अपशिष्ट पदार्थ शरीर से उत्सर्जित हो जाते हैं। उच्च प्राणियों के शरीर में अंतर्ग्रहण, पाचन, अवशोषण तथा उत्सर्जन के लिए विशेष अंग होते हैं।

उच्च जन्तुओं में भोजन का अंतर्ग्रहण मुख से होता है। भोजन दांतों द्वारा पीसकर छोटे-छोटे टुकड़ों में तोड़ दिया जाता है। मुख से भोजन के छोटे-छोटे टुकड़े भोजन की नली के द्वारा आमाशय में पहुंचते हैं। पाचन क्रिया मुख्यतः आमाशय तथा छोटी आंत में होती है। भोजन का अवशोषण छोटी आंत में होता है। भोजन का उत्सर्जन बड़ी आंत तथा गुदा में होता है।

पाचन मुख से आरंभ होता है और छोटी आंत तक चलता रहता है। आप इसके विषय में अपनी पिछली कक्षाओं में पढ़ चुके हैं। इसलिए यहां पर कुछ मुख्य धारणाओं को ही दोहराया जाएगा। मुख में स्थित दांत भोजन को पीसते हैं और लार में स्थित एंजाइम स्टार्च को रासायनिक अभिक्रिया द्वारा अपघटित होने में सहायता करते हैं। यह चबाया हुआ भोजन ईसोफेगस अथवा आहार नलिका से आमाशय में पहुँचता है। आमाशय में स्थित जठरीय एंजाइम भोजन की प्रोटीन को छोटे-छोटे अणुओं में तोड़ देते हैं। इसके बाद यह पदार्थ छोटी आंत में जाता है।

ग्रहणी (Duodenum) जो कि छोटी आंत का प्रथम भाग है उसमें अग्न्याशय के रस तथा यकृत से स्रावित पित्त भोजन पर क्रिया करते हैं। एंजाइम भोजन की प्रोटीन, कार्बोहाइड्रेट तथा वसा का पाचन करते हैं। पित्त, पदार्थों का इमल्शन बनाने में सहायता करते हैं। इस के बाद यह भोजन आंत के दूसरे भाग जिसे इलियम कहते हैं, में अवशोषित हो जाता है। वह समस्त पोषक तत्व जिनका मुख, आमाशय, ग्रहणी तथा इलियम द्वारा पाचन हुआ है, आंत अंकुरों में अवशोषित होकर रुधिर, यकृत, लसीका आदि में चले जाते हैं। अपाचित पदार्थ बड़ी आंत में पहुंच

जाते हैं और रेक्टम एवं गुदा द्वारा बाहर निकाल दिये जाते हैं। इस प्रक्रिया को **उत्सर्जन** कहते हैं।

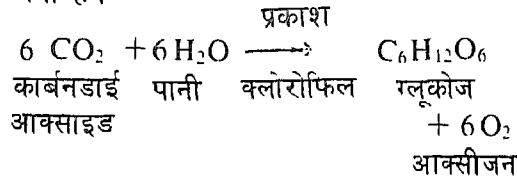
भोजन से ऊर्जा का निकास दो चरणों में होता है। पहले चरण में जटिल अणु सरल अणुओं में अपघटित होते हैं। दूसरे चरण में भोजन के सरल अणु शरीर में प्राप्त ऑक्सीजन लेकर ऑक्सीकृत होते हैं तथा कार्बन डाईआक्साइड, जल तथा ऊर्जा छोड़ते हैं। इसी चरण में श्वसन होता है जिसमें ऑक्सीजन शरीर के अन्दर आती है तथा अपशिष्ट कार्बन डाइआक्साइड बाहर निकलती है। सबसे अधिक मनोरंजक बात यह है कि पोषक प्रक्रियाओं में होने वाली अनेक रासायनिक अभिक्रियायें समस्त जीवों में उदाहरणतः खटमल, मेंढक, बाघ अथवा मनुष्य में मूलतः एकसमान होती हैं। रासायनिक प्रक्रियाओं की जो शृंखला जीवाणुओं में देखी जाती है प्रायः वही मनुष्य में भी होती है जो आदि काल से उनमें संरक्षित है। जीवों में होने वाली रासायनिक अभिक्रियायों को जैव रासायनिक अभिक्रिया कहते हैं। यह दो प्रकार की होती है: (1) **अपचय** (Catabolism) (2) **उपचय** (Anabolism)। पहली प्रक्रिया में जटिल अणु टूट कर सरल बन जाते हैं तथा दूसरी में सरल अणु से जटिल अणु बनते हैं। इन दोनों प्रक्रियाओं को मिलाकर उपापचय कहते हैं।

हरे पौधे उसका उपयुक्त उदाहरण है जो सरल पदार्थों से जटिल पदार्थ बनाते हैं। वे ऐसा सूर्य के प्रकाश से ऊर्जा लेकर करते हैं इसी लिए इस प्रक्रिया को प्रकाश संश्लेषण (Photosynthesis) कहते हैं। आइए इस प्रक्रिया के विषय में विस्तार से पढ़ें।

18.2 प्रकाश संश्लेषण

हरे पौधों में प्रकाश संश्लेषण भोजन बनाने की प्राथमिक विधि है। कार्बन तथा हाइड्रोजन के आक्साइड (CO_2 तथा H_2O) सूर्य के प्रकाश से ऊर्जा लेकर पौधों की कोशिकाओं में कार्बोहाइड्रेट (ग्लूकोज) के रूप में स्थिर हो जाते हैं। प्रकाश संश्लेषण का रासायनिक समीकरण नीचे दिया गया है।

$$6\,CO_2 + 6\,H_2O \xrightarrow[\text{क्लोरोफिल}]{\text{प्रकाश}} C_6H_{12}O_6 + 6\,O_2$$

कार्बनडाई आक्साइड, पानी, क्लोरोफिल, ग्लूकोज, आक्सीजन

पौधों में न केवल कार्बन डाइआक्साइड (CO_2) तथा पानी (H_2O) ही कार्बोहाइड्रेट रूप में स्थिर होते हैं बल्कि सूर्य से प्राप्त ऊर्जा भी स्थिर होती है। इसका अर्थ यह है कि हम सब प्रतिदिन भोजन में अप्रत्यक्ष रूप में सूर्य का प्रकाश ग्रहण करते हैं। क्योंकि पौधे सूर्य के प्रकाश को भोजन के रूप में स्थिर करते हैं। प्रत्यक्षरूप से जन्तु अपना भोजन पौधों और उनके उत्पादों से प्राप्त करते हैं और अप्रत्यक्ष रूप से जब वे अन्य जन्तुओं को खाते हैं क्योंकि ये जन्तु भी तो पौधों पर ही निर्भर होते हैं। पौधे सूर्य के प्रकाश को परिवर्तित करके कार्बनिक पदार्थ के रूप में इकट्ठा करते हैं। हम इन पदार्थों को अपने भोजन में लेते हैं। हवा में ऑक्सीजन भी अधिकतर पौधों की प्रकाश संश्लेषण की क्रिया से आती है। पृथ्वी पर पौधों के आने से पहले हवा में ऑक्सीजन की मात्रा न के बराबर थी। वायु में ऑक्सीजन की मात्रा पौधों के पृथ्वी पर आने तथा उनकी प्रकाश संश्लेषण प्रक्रिया से ही अधिक हुई है। यह प्रक्रिया 280 करोड़ वर्ष पहले आरम्भ हुई थी। वायु में आक्सीजन होने से ही उच्च जन्तुओं का उदय हुआ तथा उन्होंने वृद्धि की।

प्रकाश संश्लेषण के लिए आवश्यक कच्चे पदार्थ

पौधे अपना भोजन चार पदार्थों कार्बन-डाइआक्साइड, पानी, क्लोरोफिल और सूर्य के प्रकाश से बनाते हैं।

कार्बन डाइआक्साइड

आप जानते हैं कि श्वसन क्रिया में कार्बन डाइआक्साइड निकलती है। पौधे इस कार्बन डाइआक्साइड का उपयोग करने की क्षमता रखते हैं। वे इसे अपना भोजन बनाने के लिए उपयोग करते हैं। स्थलीय पौधे वायु मण्डल से कार्बन डाइआक्साइड लेते हैं जबकि जलीय पौधे पानी में घुली हुई कार्बन डाइआक्साइड लेते हैं। दिन के समय जब प्रकाश उपलब्ध रहता है, तब पौधे प्रकाश संश्लेषण में कार्बन डाइ आक्साइड का उपयोग करके उसको स्थिर कर देते हैं। रात के समय वे प्रकाश संश्लेषण की क्रिया नहीं करते बल्कि संचित स्टार्च का उपापचयन करते हैं और कार्बनडाइआक्साइड़ छोड़ते हैं। जब प्रकाश संश्लेषण की दर कम होती है जैसे छाया में या उषा काल या सायंकाल, तब श्वसन में निकली कार्बन डाइआक्साइड प्रकाश संश्लेषण क्रिया के लिए पर्याप्त होती है। यह अवस्था जिसमें कार्बन डाइ आक्साइड का अंर्तग्रहण नहीं होता संतुलन प्रकाश तीव्रता (Compensation point) कहलाती है।

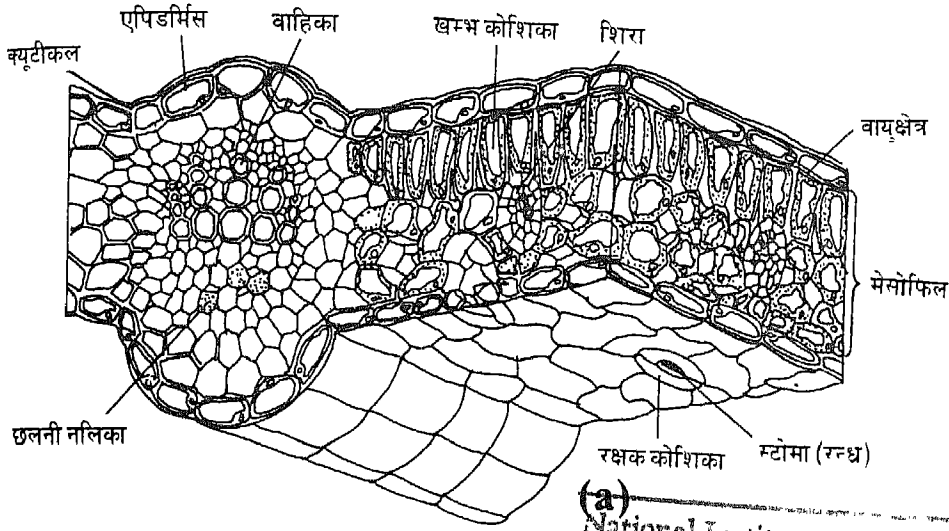
जल

आप देखते हैं कि किसान अपनी फसलों को पानी देते हैं। वे ऐसा क्यों करते हैं। पौधों की जड़ें इस पानी को अवशोषित करती हैं और जाईलम द्वारा पत्तियों तक पहुंचा देती हैं। पौधे पानी के साथ-साथ अधिकांश खनिज लवण भी अवशोषित करते हैं। खनिज लवण भी प्रकाश संश्लेषण की क्रिया को पूरा करने में अपना योगदान देते हैं।

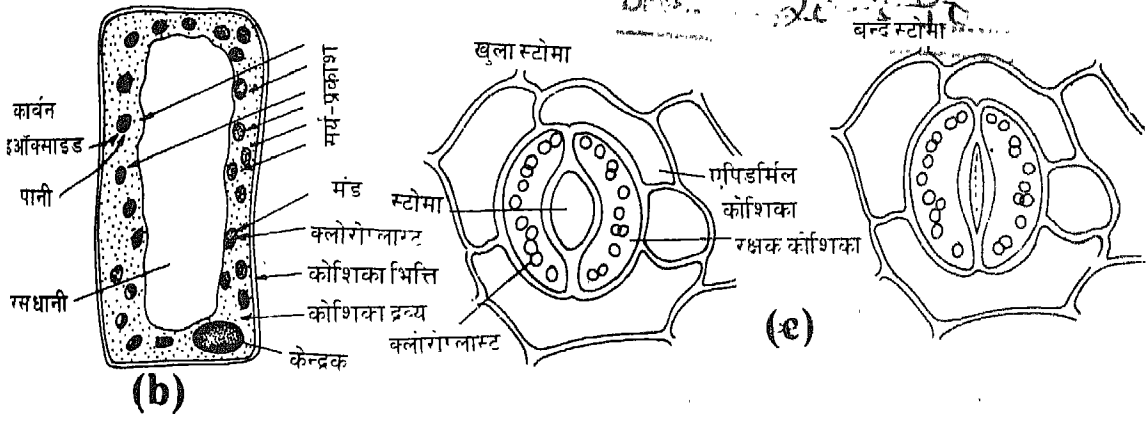
क्लोरोफिल (Chlorophyll)

क्लोरोफिल पत्तों में हरे रंग का वर्णक है। इसके चार घटक हैं। क्लोरोफिल ए, क्लोरोफिल बी, कैरोटिन तथा जैंथोफिल। इनमें से क्लोरोफिल ए और बी हरे रंग के होते हैं और ऊर्जा स्थानांतरित करते हैं। क्लोरोफिल प्रकाश संश्लेषण के लिए आवश्यक है। इसलिए जिन कोशिकाओं में क्लोरोफिल होता है उन्हीं कोशिकाओं को प्रकाश संश्लेषी कहते हैं। पौधों में क्लोरोफिल अधिकतर पत्तों में पाया जाता है इसलिए पत्तों को प्रकाश संश्लेषी अंग कहते हैं। पत्तों की कुछ कोशिकाओं में क्लोरोप्लास्ट नाम का अंगक होता है जिसमें क्लोरोफिल पाया जाता है। क्लोरो-प्लास्ट को पौधे का प्रकाश संश्लेषी अंगक कहते हैं। छोटे हरे तनों तथा फलों में अधिकतर पर्याप्त मात्रा में क्लोरोफिल होता है। अन्य अंगों में भी क्लोरोफिल होता है। शैवाल का लगभग सारा पौधा ही प्रकाश संश्लेषी है।

प्रकाश

प्रकाश संश्लेषण मे सूर्य प्रकाश का प्राकृतिक स्रोत है, परन्तु कुछ कृत्रिम स्रोत भी इस क्रिया को करने में समर्थ होते हैं। क्लोरोफिल प्रकाश में से बैंगनी, नीला तथा लाल रंग को ग्रहण करता है। परन्तु प्रकाश संश्लेषण की दर लाल प्रकाश में

चित्र 18.1 (a) पत्ती की काट।

चित्र 18.1 (b) खंभ कोशिका।

चित्र 18.1 (c) रन्ध्र (स्टोमैटा)।

सबसे अधिक होती है।

चित्र 18.1 में पत्ते की काट को दर्शाया गया है। मोमी क्यूटीकल तथा पतली सी एपिडर्मिस (Epidermis) पत्ते के बाहरी भाग को बनाते हैं। प्रकाश संश्लेषण खंभ कोशिकाओं (Palisade cells) में होता है जिसे चित्र 18.1b में दर्शाया गया है। पानी शिरा से परासरण द्वारा और कार्बन डाइ आक्साइड वायुमंडल से विसरण द्वारा कोशिकाओं में जाती है। सूर्य के प्रकाश को क्लोरोफिल ग्रहण करता है। इस ऊर्जा से तथा

कई एंजाइम की सहायता से कार्बन डाइआक्साइड तथा पानी क्लोरोप्लास्ट में मिलकर शर्करा बनाते हैं। इस अभिक्रिया में पत्ते की कोशिका से ऑक्सीजन निकल कर वायु-मण्डल में जाती है। कुछ एंजाइम स्टार्च पर क्रिया करके भी शर्करा बनाते हैं, जैसे सुक्रोस। यह शर्करा फ्लोएम द्वारा पौधों में उपापचय तथा संचयन के लिए भेजा जाता है। प्रकाश संश्लेषण के अध्ययन के लिए यहाँ कुछ सरल क्रिया कलाप दिए गए हैं। क्रिया कलाप ऐसे पौधों से आरम्भ करना लाभदायक होता है जिनमें स्टार्च कम हो। इससे आप स्टार्च के उत्पादन का भी आसानी से परीक्षण कर सकेंगे। पत्ती को स्टार्च रहित करने के लिए पौधों को तीन दिन के लिए अंधेरे में रखा जाता है।

क्रियाकलाप – 1

सूर्य के प्रकाश में रखे हुए पौधों से एक पत्ता तोड़िए। इसको कुछ मिनट उबलते हुए पानी में डालिए। इससे पत्ते में स्थित एंजाइम नष्ट हो जाएंगे तथा पत्ता नर्म और अधिक उदग्रहित हो जाएगा। अब पत्ते को एल्कोहल में डालकर जल कुंडिका में उबालिए ताकि पत्ते में से सारा क्लोरोफिल निकल जाये और पत्ता सफेद हो जाए। इससे रंगों को आसानी से देखा जा सकता है। पत्ते को पुनः नर्म करने के लिए गर्म पानी में डालिये। आयोडीन के घोल की कुछ बूंदे पत्ते पर डालिये। पत्ते के जिस भाग में स्टार्च होगा वह आयोडीन से नीला हो जाएगा। अगर पत्ते में स्टार्च नहीं है तो पत्ता भूरे रंग का हो जाएगा। एक स्टार्च रहित पत्ते को तुलना के लिए रखिये।

क्रियाकलाप – 2

प्रकाश की आवश्यकता के लिए परीक्षण

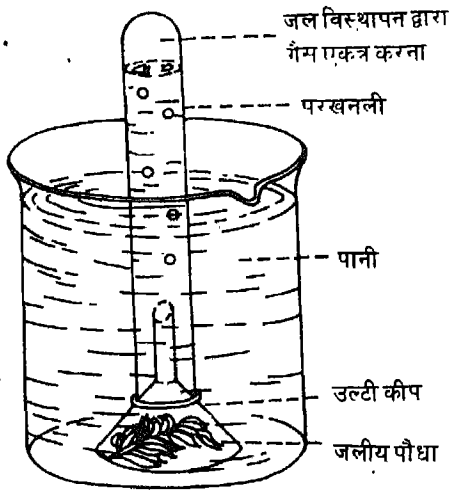
एक स्टार्च रहित पौधा लें। इसके एक पत्ते को कार्बन पेपर से ढक दें। जिससे इस पत्ते पर प्रकाश न पड़े। पौधे को 6 घण्टे के लिए सूर्य के प्रकाश में रख दें। अब ढके हुए पत्ते को स्टार्च के लिए टैस्ट करें जैसा क्रियाकलाप 1 में किया था। जिस पत्ते को सूर्य का प्रकाश नहीं मिला है उसमें बहुत कम स्टार्च होगा, जबकि दूसरा पत्ता स्टार्च होने का प्रमाण दिखाएगा।

क्रियाकलाप – 3

स्टार्च रहित पौधे वाले दो गमले लें और उन्हें प्लास्टिक की थैली से ढक दें। ऐसा करने से पौधों को प्रकाश तो मिल जाएगा लेकिन ताजी हवा नहीं मिल पाएगी। एक में कुछ सोडा लाइम रख दें। सोडा लाइम कार्बन डाइआक्साइड को अवशोषित कर लेता है। दूसरे में सोडियम बाइकार्बोनेट ($NaHCO_3$) का घोल रखें। ऐसा करने से इस पौधे को अधिक कार्बन डाइ आक्साइड मिलेगी। दोनों गमलों को 6 घण्टों के लिए सूर्य के प्रकाश में रख दें। दोनों पौधों का एक एक पत्ता लेकर स्टार्च के लिए टैस्ट करें। जिस पौधे में सोडा लाइम रखा था उसके पत्ते में स्टार्च नहीं होगा क्योंकि इस पौधे को कार्बन डाइआक्साइड नहीं मिली।

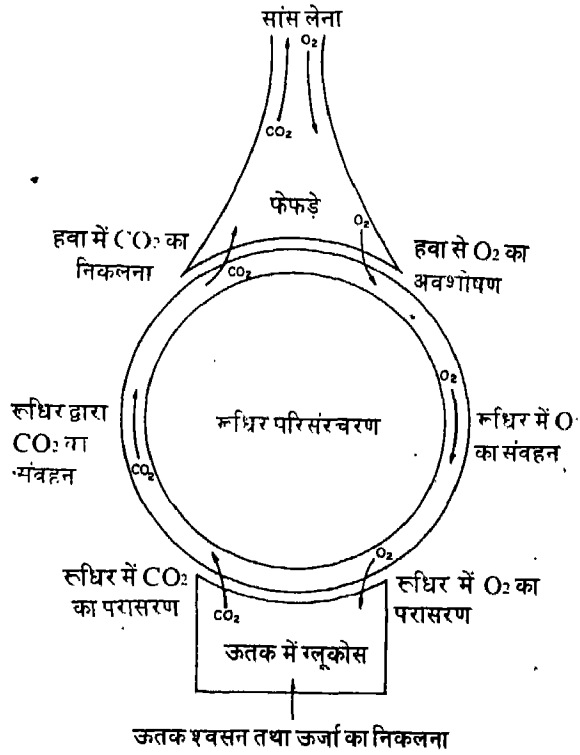
क्रियाकलाप – 4

इस क्रियाकलाप द्वारा यह दिखाया जा सकता है कि प्रकाश संश्लेषण में ऑक्सीजन एक उपोत्पाद के रूप में निकलती है। एक बीकर, फ़नल, जलीय पौधा (हाईड्रिला), परख नली, पानी और थोड़ा बेकिंग सोडा लें। बीकर को पानी से आधा भर दें। हाईड्रिला की कुछ टहनियाँ इसमें रख दें। पौधे को फनल से ढक दें। परख नली को भी पानी से

भर दें। पानी से भरी हुई परख नली को फलन की डंडी पर रख दें। जैसा चित्र 18.2 में दिखाया गया है। इस उपकरण को सूर्य के प्रकाश में रख दें। कुछ देर के बाद आप बुलबुले निकलते हुए देखेंगे। जो परख नली के ऊपरी भाग में एकत्र हो जाते हैं। पानी का स्तर परख नली से नीचे आ गया है। टैस्ट करने पर पता चलेगा कि परख नली की गैस ऑक्सीजन है।

चित्र 18.2 प्रकाश संश्लेषण में ऑक्सीजन के निकलने को दिखाने के लिए एक प्रयोग।

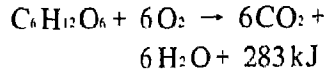
नोट: यदि पौधे से बुलबुले निकलने की दर कम हो तो पानी में थोड़ा सा बेकिंग सोडा डाल सकते हैं।

श्वसन

प्रकाश संश्लेषण में प्रकाशिक ऊर्जा रासायनिक ऊर्जा में बदलती है और कार्बोहाइड्रेट जैसे ग्लूकोस तथा स्टार्च के रूप में एकत्रित होती है। इन योगिकों के टूटने तथा रासायनिक ऑक्सीकरण से पर्याप्त ऊर्जा निकलती है जिसका उपयोग जीव करते हैं। दूसरे शब्दों में कह सकते हैं कि कार्बोहाइड्रेट के ऑक्सीकरण से ऊर्जा निकलती है तथा यह अभिक्रिया ऑक्सीजन अन्दर लेने के दौरान होती है। इस प्रक्रिया में उत्पादित कार्बन डाइआक्साइड सांस द्वारा बाहर छोड़ी जाती है। इस प्रक्रिया में जो यौगिक आक्सीकृत होते हैं उन्हें श्वसनी पदार्थ कहते हैं। श्वसनी पदार्थों से सारी ऊर्जा एकसाथ नहीं निकलती है, बल्कि धीरे-धीरे एक के बाद एक होने वाली रासायनिक अभिक्रियाओं द्वारा निकाली जाती है

चित्र 18.3 श्वसन में मनुष्य के शरीर में मूलभूत प्रक्रियाएँ होती हैं।

जिन्हें श्वसन की अपचय अभिक्रिया कहते हैं। श्वसन के दौरान ऊर्जा उसी प्रकार प्राप्य है जैसा कि किसी भी ऑक्सीकरण अभिक्रिया से प्राप्य है।

श्वसन को प्रकाश संश्लेषण के विपरीत समझा जाता है। प्रकाश संश्लेषण उपचय है और श्वसन अपचय। श्वसन की इस अभिक्रिया को नीचे दिया गया है।

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 283\,kJ$$

चित्र 18.3 में मनुष्य के शरीर में श्वसन के दौरान प्रमुख प्रक्रियाओं को दिखाया गया है।

पौधे प्रकाश और अंधेरे में संश्लेषण और श्वसन दोनों ही करते हैं। परंतु जिस दर से यह प्रक्रियायें होती हैं वह प्रकाश की तीव्रता पर निर्भर करता है। ये दोनों प्रक्रियाएं सांध्य प्रकाश में एक दूसरे को संतुलित करती हैं। इसलिए ऊपर हमने संतुलन प्रकाश तीव्रता के विषय में बताया था।

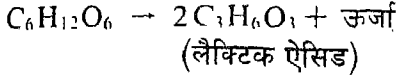
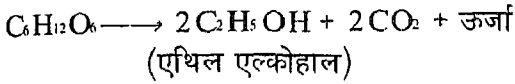
क्या श्वसन और सांस लेने की प्रक्रियाएं एक समान होती हैं? श्वसन तथा सांस लेने की क्रिया भिन्न-भिन्न हैं। सांस लेना एक भौतिक क्रिया है। सांस लेने में निश्वसन के समय जीव वातावरण से ऑक्सीजन लेता है जो फेफड़ों में जाती है जहां से वह रक्त द्वारा अवशोषित कर ली जाती है। उच्छवसन में कार्बन डाइ ऑक्साइड तथा पानी की वाष्प बाहर निकलती हैं। सांस लेने की प्रक्रिया अधिकतर उच्च वर्गीय जीवों में होती है। छोटे तथा सूक्ष्मदर्शी जन्तुओं में सांस लेने के लिए हमारी तरह नाक तथा फेफड़े नहीं होते हैं। वे ऑक्सीजन तथा अन्य गैसें विसरण द्वारा लेते हैं। श्वसन में रासायनिक ऑक्सीकरण क्रिया ऑक्सीजन का प्रयोग करते हुए होती है। इसमें सांस लेने वाले अंगों जैसे नाक तथा फेफड़ों की आवश्यकता नहीं होती है। यहां तक कि सूक्ष्मदर्शी जीव भी श्वसन करते हैं। जैव ऑक्सीकरण के नियम सभी जीवों के लिए चाहे वे जीवाणु हों या मनुष्य एक समान हैं। यद्यपि जीवों में रचनात्मक विविधता होती है परन्तु श्वसन क्रिया सभी में एक समान है। श्वसन जीवों में प्रकार्यात्मक एकता का एक अन्य उदाहरण है।

श्वसन में यौगिकों का ऑक्सीकरण होता है और ऊर्जा निकलती है। हमें ऊर्जा ऊष्मा के रूप में तब भी मिलती है जब किसी यौगिक को हवा में जलाकर उसका ऑक्सीकरण किया जाता है। तब क्या श्वसन और दहन एक ही प्रक्रिया हैं? दहन में वायु की ऑक्सीजन यौगिक से संयोग करती है और इसमें एक ही चरण में सारी ऊर्जा निकल जाती है। इससे ताप तथा प्रकाश के रूप में ऊर्जा की हानि हो जाती है। ईंधन के जलने से कार्बन डाइ आक्साइड तथा पानी बनते हैं। दूसरी ओर श्वसन में ऊर्जा धीरे धीरे निकलती है। यह ऊर्जा एडिनोसिन ट्राइफोस्फेट (ATP) जैसे विशेष यौगिक में संचित हो जाती है। ATP के जल अपघटन द्वारा आवश्यकतानुसार इस संचित ऊर्जा का उपयोग किया जा सकता है। इस प्रकार ATP जैव कोशिकाओं में रासायनिक ऊर्जा का सार्विक वाहक है। दहन उच्च ताप पर होता है जबकि श्वसन 25°—40° C जैसे सामान्य ताप पर हो सकता है। जैव ऑक्सीकरण में उपयोग होने वाले श्वसन पदार्थ हैं ग्लूकोस, वसा, ऐमीनो ऐसिड और प्रोटीन। इनमें से ग्लूकोस नामक यौगिक का उपयोग प्रायः श्वसन में होता है। ऑक्सीकरण तथा ग्लूकोस के सरलीकरण की सभी अभिक्रियाएं दो चरणों में पूरी होती हैं। पहले चरण में ऑक्सीजन की

आवश्यकता नहीं होती है। इस अभिक्रिया में केवल थोड़ी सी ही ऊर्जा निकलती है। इस चरण में ग्लूकोस आंशिक रूप से लैक्टिक ऐसिड या एथिल ऐल्कोहॉल में टूटता है। ऐसे श्वसन को अनऑक्सी श्वसन कहते हैं।

$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$ + ऊर्जा
(लैक्टिक ऐसिड)

(यह अभिक्रिया पेशीयों में तथा जीवाणु में होती है)

$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$ + ऊर्जा
(एथिल एल्कोहाल)

(यह अभिक्रिया यीस्ट में होती है)

श्वसन का दूसरा चरण आक्सीकरण की उपस्थिति में होता है इसलिए इसे ऑक्सी श्वसन कहते हैं। इसमें शर्करा के अणु जो अनआक्सी चरण में आधे टूटे थे पूरी तरह से ऑक्सीकृत हो जाते हैं। इससे कार्बन डाइ ऑक्साइड और ऊर्जा बाहर निकलती है। इस अभिक्रिया में अधिक मात्रा में ऊर्जा निकलती है। ग्लूकोस का एक अणु ATP के 38 अणु देता है।

श्वसन में हम ऑक्सीजन लेते हैं और कार्बन डाइ ऑक्साइड छोड़ते हैं। जो वायु हम लेते हैं उसमें ऑक्सीजन की मात्रा अधिक होती है और जो बाहर निकालते हैं उसमें कार्बन डाइ ऑक्साइड की मात्रा अधिक होती है।

तालिका 18.1 में यह दर्शाया गया है।

तालिका 18.1

श्वसन में वायु का संघटन

	अन्दर ली हुई वायु	बाहर निकाली हुई वायु
नाइट्रोजन	79%	79%
ऑक्सीजन	21%	17%
कार्बन डाइ ऑक्साइड	0.03%	4%
पानी की वाष्प	परिवर्तनीय	संतृप्त

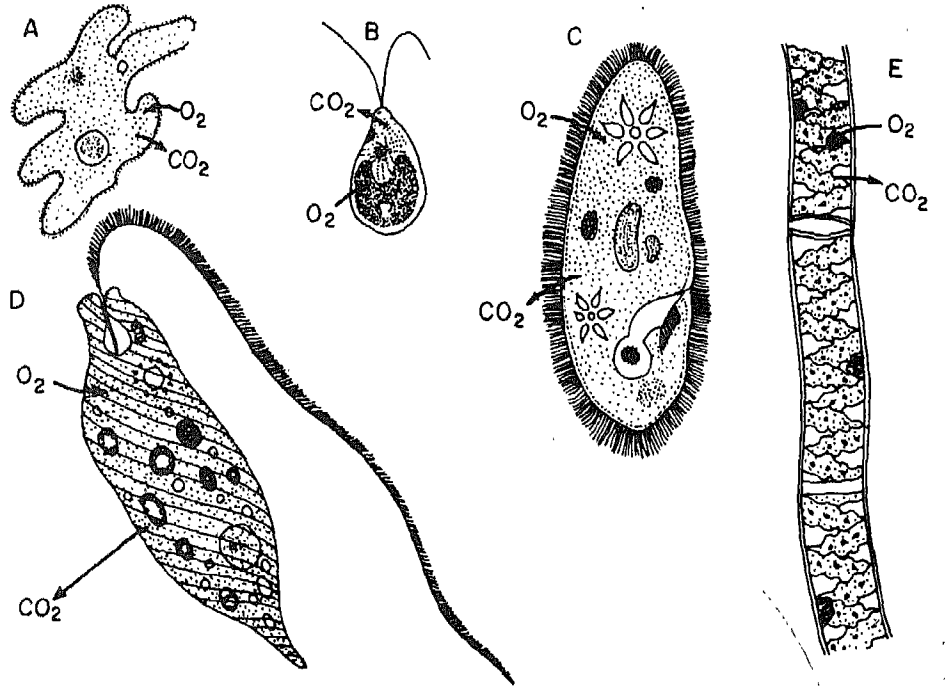
सांस द्वारा हमारे शरीर से लगभग 400 ml पानी प्रतिदिन निकलता है।

श्वसन की समस्त क्रियाएं कोशिका में होती हैं और ये क्रियाएं अनेकों एंजाइम के माध्यम से पूर्ण होती हैं। इनमें से अधिकांश एंजाइम माइटोकॉन्ड्रिया में स्थित होते हैं। माइटोकॉन्ड्रिया थैले की आकृति के होते हैं। यह सभी जीवित कोशिकाओं में पाये जाते हैं। इसे कोशिका का शक्ति केन्द्र भी कहते हैं क्योंकि ये श्वसन की सारी ऑक्सीकारक अभिक्रियाएं करते हैं और ऊर्जा प्रदान करते हैं।

वायु से ऑक्सीजन लेने तथा श्वसन कोशिका से कार्बन डाइ ऑक्साइड निकालने की भिन्न-भिन्न विधियां हैं। पौधों में यह विधि बहुत सरल है। इनमें हवा, स्टोमेटा, लैंटिसेल, तथा अन्तर कोशिकीय स्थानों से विसरित होती है। पानी में निमग्न पौधों तथा छोटे जानवरों में हवा शरीर से विसरित होती है। चित्र 18.4 में इन जीवों के कुछ उदाहरण दिखाए गए हैं।

उच्च वर्गीय जीवों में गैस विनिमय सांस लेने की विशेष प्रक्रिया से होता है। विभिन्न जन्तुओं में सांस लेने के विभिन्न अंग पाए जाते हैं। उदाहरण के लिए मछली गिल द्वारा श्वसन करती है तथा स्थलीय जन्तु फेफड़ों तथा नासिका द्वारा श्वसन करते हैं।

18.4 पदार्थों का संवहन

भोजन और पाचित पदार्थों को अवशोषण के स्थान से उपयोग के स्थान तक पहुँचाना आवश्यक है। अपशिष्ट पदार्थों को भी शरीर से बाहर निकालना आवश्यक है। भिन्न-भिन्न जीवों में सवहन की

चित्र 18.4 बहुत से निम्नवर्गीय जीव विसरण प्रक्रिया द्वारा ऑक्सीजन लेते हैं। जैसे— (a) अमीबा, (b) क्लैमिडोमोनास, (c) पैरामीशियम, (d) यूग्लीना, (e) स्पाइरोगाइरा।

विधियाँ भिन्न-भिन्न होती हैं। परन्तु सभी जीव कुछ सामान्य नियमों का पालन करते हैं। आइये हम इनमें से कुछ के विषय में जानें।

एक कोशिकीय जीवों जैसे **क्लैमिडोमोनास**, शैवाल, **अमीबा**, **पैरामीशियम** तथा कुछ बहु-कोशिकीय जीवों जैसे हाइड्रा में पदार्थों का संवहन मुख्यतः विसरण विधि द्वारा होता है। विसरण की प्रक्रिया में अणु सान्द्र क्षेत्र से तनु क्षेत्र की ओर जाते हैं और यह प्रक्रम तब तक चलता रहता है जब तक कि सांद्रता एकसमान न हो जाए। पदार्थों का विसरण ठोस तथा द्रव की अपेक्षा गैसीय स्थिति में अधिक होता है। प्रकाश संश्लेषण में पत्तियों में कार्बन डाइऑक्साइड का उपयोग कोशिका द्रव्य में होता है जिससे कार्बोहाइड्रेट बनता है। इस कारण कोशिका में कार्बन डाइऑक्साइड का स्तर कम हो जाता है तथा हवा और अन्तर कोशिकीय स्थानों के बीच विसरण प्रवणता बनती है। इसके परिणाम स्वरूप कार्बन डाइऑक्साइड वातावरण से कोशिका में विसरित होती है। प्रकाश संश्लेषण में ऑक्सीजन गैस उत्पन्न होती है और ऑक्सीजन की प्रवणता कार्बन डाइऑक्साइड से विपरीत दिशा में बनती है। इसके परिणाम स्वरूप

ऑक्सीजन पत्तों से निकल कर हवा में विसरित हो जाती है। विसरण सभी दिशाओं में होता है। जितना क्षेत्रफल अधिक होगा विसरण भी उतना ही अच्छा होगा। अब आप समझ गए होंगे कि पत्ते का क्षेत्रफल अधिक होने से क्या लाभ हैं। परासरण विसरण की एक विशेष प्रकार की प्रक्रिया है। इस प्रक्रिया में अणु तनु घोल से सांद्र घोल की ओर अर्धपरागम्य झिल्ली की सहायता से जाते हैं।

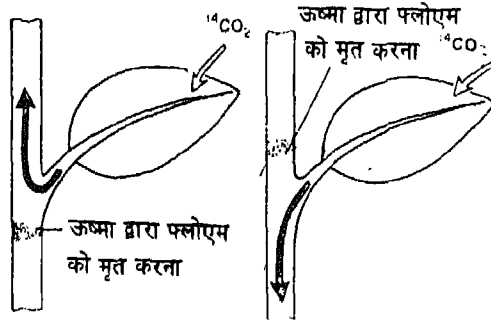
संवहन की क्रिया विधि उच्च वर्गीय जन्तुओं में अधिक जटिल होती है। इसका कारण यह है कि उनकी आवश्यकता अधिक होती है जो कि विसरण से पूरी नहीं हो पाती। इनमें संवहन करने की विशेष नालियाँ तथा संवहन वाहिकाएं होती हैं। पौधों में यह नालियां जाइलम तथा फ्लोएम के रूप में होती हैं। उच्च वर्गीय जन्तुओं में परिसंचरण तंत्र होता है। इस तंत्र में रुधिर पदार्थों को एक स्थान से दूसरे स्थान पर ले जाता है तथा हृदय एक पंप की तरह कार्य करता है। दाब उत्पन्न करने के लिए आइये हम पहले पौधों में संवहन तंत्र के विषय में पढ़े।

पत्ते की निचली सतह पर विशेष प्रकार के छिद्र होते हैं जिन्हें स्टोमेटा कहते हैं। स्टोमेटा के दोनों ओर दो रक्षक कोशिकाएं होती हैं। आंतरिक दाब या स्फीति दाब में परिवर्तन के कारण स्टोमा का आकार भी बदलता रहता है। इनका साइज कभी कम होता है तो कभी अधिक और कभी ये बिल्कुल बंद भी हो जाते हैं। प्रकाश की तीव्रता और पानी की हानि, ये दो कारक स्टोमेटा के खुलने तथा बंद होने पर नियंत्रण रखते हैं। चित्र 18.1c में स्टोमा का खुलना तथा बंद होना दिखाया गया है। पौधों में गैस विनिमय जैसे कार्बन डाइऑक्साइड अन्दर लेना तथा ऑक्सीजन बाहर निकालना स्टोमेटा के द्वारा होता है।

स्टोमेटा कैसे खुलता है और बन्द होता है? जैसे-जैसे प्रकाश संश्लेषण प्रक्रिया आगे बढ़ती है पत्तों में कार्बन डाइऑक्साइड का स्तर गिरता जाता है और शर्करा का स्तर बढ़ता जाता है। शर्करा अधिक होने के कारण परासरण दाब या स्फीति दाब में परिवर्तन होता है। इससे रक्षक कोशिका मुड जाती हैं और स्टोमा खुल जाते हैं।

पौधों में पानी, घुली हुई शर्करा तथा अन्य पदार्थों का संवहन दो विधियों से होता है:

1. स्थानांतरण:– इससे घुले हुए पदार्थों का स्थानांतरण पौधों में होता है।
2. वाष्पोत्सर्जन:– इसमें पत्तों से पानी का वाष्पीकरण होता है जिसके कारण जाइलम से पानी का संवहन होता है। पानी तथा घुले हुए लवण प्रायः जाइलम के द्वारा मिट्टी से ऊपर की ओर जाते हैं। पत्तों में निर्मित भोजन फ्लोएम की चालनी नलिकाओं (Sieve tubes) से पौधों के अन्य भागों में जाता है। चित्र 18.5 में फ्लोएम द्वारा स्थानांतरण दिखाया गया है।

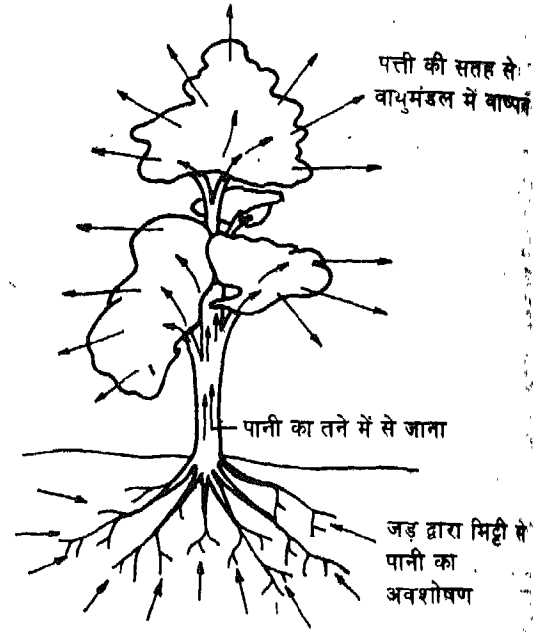
वाष्पोत्सर्जन एक ऐसी प्रक्रिया है जिसके कारण पेड़-पौधे पानी को वातावरण में छोड़ते हैं। पानी की हानि मुख्यतः पत्तियों द्वारा होती है। जब स्फीति दाब बढ़ता है तब पानी कोशिका भित्ती से बाहर निकल कर अन्तर कोशिकीय स्थानों में आ जाता है। यहां पर पानी से वाष्प बनती हैं जो स्टोमेटा द्वारा बाहर निकल

चित्र 18.5 फ्लोएम द्वारा संवहन का प्रमाण। प्रकाश संश्लेषण में उपयोग होने के लिए रेडियोधर्मी कार्बन डाइऑक्साइड पौधे को दी गई। जब किसी दिशा में स्थित फ्लोएम को गरम करके बन्द कर दिया गया तब देखा गया कि रेडियोधर्मी वाला उत्पाद विपरीत दिशा में स्थित फ्लोएम में चला गया।

जाती है। जब स्टोमेटा बन्द होते हैं उस समय पानी की हानि बहुत कम होती है।

पानी में संवहन के कारण घुले हुए पदार्थ तथा पानी जड़ों तथा जाइलम द्वारा पौधे में ऊपर जाते हैं। पत्तियों से पानी के वाष्प बनकर उड़ने के कारण स्फीति दाब कम हो जाता है। इससे जाइलम नलिकाओं में एक अटूट स्तम्भ सा बन जाता है और यदि किसी समय दाब कम हो जाता है तो पानी का स्तर भी बदल जाता है जिसके कारण मिट्टी से पानी पौधे में ऊपर की ओर चढ़ता है। यह प्रक्रिया कुछ इस प्रकार है जैसे ड्रापर में लगी रबर को दबाने से स्याही दवात से ड्रापर में चढ़ जाती है।

चित्र 18.6 में पौधे में वाष्पोत्सर्जन की प्रक्रिया को दिखाया गया है।

18.5 रुधिर परिसंचरण

मनुष्य में पदार्थों का स्थानांतरण रुधिर

चित्र 18.6 वाष्पोत्सर्जन तन्त्र। जड़ें मिट्टी से पानी को अवशोषित करती हैं और जाइलम द्वारा तने तक पहुँचाती हैं। इसमें से कुछ पत्तियों की सतह से पानी वातावरण में वाष्पित हो जाता है।

परिसंचरण द्वारा होता है (चित्र 18.7)।

रुधिर तरल माध्यम है जिसके द्वारा पदार्थों का स्थानांतरण होता है। रुधिर में बहुत घटक होते हैं:—

(अ.) लाल रुधिर कोशिकाएं (Erythrocytes) —इनमें हीमोग्लोबिन नामक प्रोटीन अणु होता है। मनुष्य में ही हीमोग्लोबिन ऑक्सीजन तथा कार्बन डाइऑक्साइड का वाहक होता है।

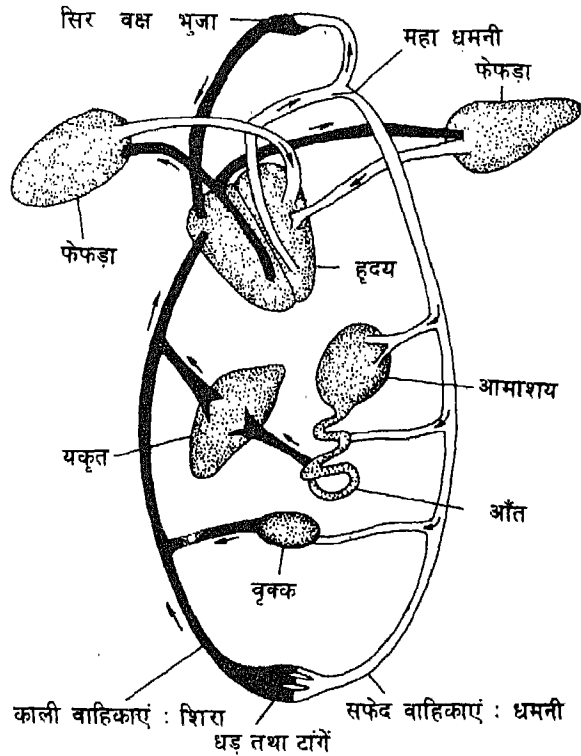
(ब.) श्वेत रुधिर कोशिकाएं (Leucocytes) —ये हानिकारक जीवाणुओं तथा मृत

कोशिकाओं का अंतर्ग्रहण करती हैं और उन्हें नष्ट कर देती हैं। ये कोशिकाएं किसी संक्रमण तथा घाव होने पर हमारे शरीर में रक्षा बल की तरह कार्य करती हैं।

(स.) पट्टिकाणु कोशिकाएं – ये रुधिर के थक्के जमा देती है जिससे मूल्यवान तरल रुधिर की हानि नहीं हो पाती।

(द.) प्लाज़्मा – यह रुधिर का तरल भाग है। इसमें बहुत से लवण, ग्लूकोस, ऐमीनो ऐसिड, प्रोटीन, हार्मोन तथा पाचित एवं अपाचित खाद्य पदार्थ घुले होते हैं। सीरम रुधिर प्लाज्मा है जिसमें से रुधिर के थक्के जमाने वाले फाइब्रिनोजन नामक प्रोटीन को निकाल लेते हैं। इस प्रकार रुधिर दो कार्य करता है (1) परिसंचरण तथा (2) शरीर के भीतरी वातावरण को संतुलित एवं स्थिर रखना।

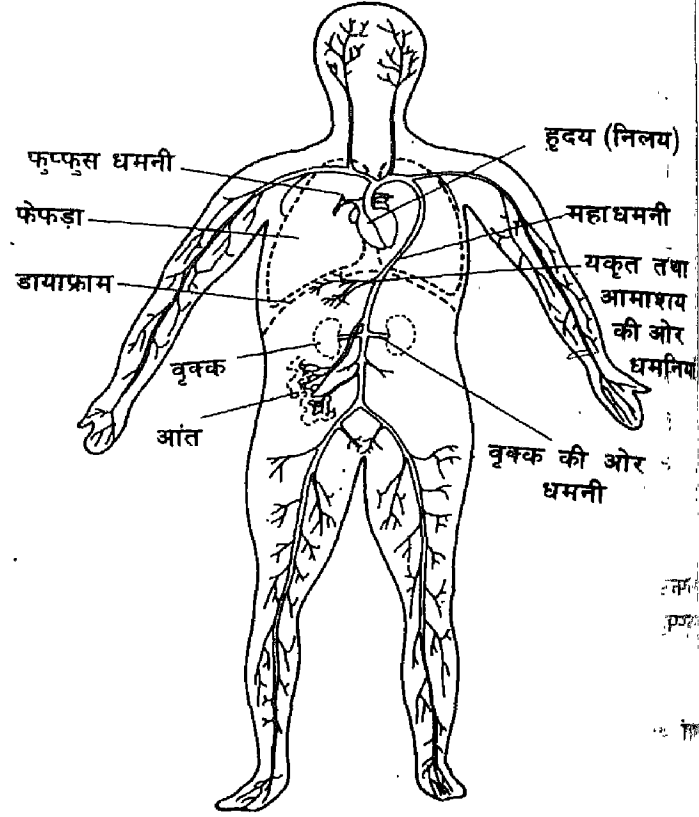
रुधिर परिसंचरण तरल होने के कारण बहुत प्रकार के पदार्थों का संवहन करता है।

1. यह ऑक्सीजन को फेफड़ों से ऊतकों तक और
2. कार्बन डाइऑक्साइड को ऊतकों से फेफड़ों तक पहुँचाता है। लाल रुधिर कोशिकाओं में स्थित हीमोग्लोबिन फेफड़ों की सतह से विसरित ऑक्सीजन को ले लेता है और इसे कोशिकाओं में पहुंचा देता है जहां पर इसका उपयोग होता है। हीमोग्लोबिन खाद्य पदार्थों के ऑक्सीकरण से उत्पन्न कार्बन डाइऑक्साइड को लेता है और उसे फेफड़ों में पहुंचा देता है जहां से विसरण विधि द्वारा यह शरीर से बाहर निकल जाती है।
3. रुधिर तंत्र की कोशिकाएं (और लसिका तंत्र) बहुत से उपापचयी अपशिष्ट पदार्थों तथा विषैले उपोत्पादों को उत्सर्जन के लिए वृक्क में ले जाती हैं।
4. छोटी आंत (इलियम) से पाचित पदार्थ रुधिर प्लाज्मा में आते हैं और यकृत में चले जाते हैं और उसके बाद परिसंचरण तंत्र में शामिल हो जाते हैं।
5. रुधिर हार्मोन जैसे रासायनिक पदार्थों को जो शरीर में उपापचयन, वृद्धि तथा विकास को नियमित करते हैं उत्पादन स्थलों से उपयोग करने वाले अंगों में पहुंचाता है।

चित्र 18.7 मनुष्य में परिसंचरण तन्त्र।

6. परिसंचरण तरल ऊष्मा का वितरण कर शरीर के ताप को स्थिर रखता है।

7. रुधिर का थक्का जमाने वाला, घाव का उपचार करने वाला तथा संक्रमण एवं रोगों से लड़ने वाले पदार्थ भी रुधिर द्वारा ही स्थानांतरित होते हैं।

चित्र 18.7 से पता चलता है कि परिसंचरण एक पम्प द्वारा होता है। इस पम्प को हृदय कहते हैं। हृदय की पेशियों के आवर्तीय रूप से सिकुड़ने के कारण रुधिर निकलता है। रुधिर का बहाव सदैव एक ही दिशा में होता है जैसा कि चित्र में तीरों से दिखाया गया है। रुधिर वाहिकाएं विभिन्न साइज की होती हैं। इसके मोटी से मोटी वाहिका के व्यास का माप 1 cm से लेकर पतली वाहिका का 0.001 mm तक होता है। धमनी, शिरा तथा केशिका तीन प्रकार की रुधिर वाहिकाएं हैं। ये तीनों आपस में एक दूसरे से जुड़ी रहती हैं जिस कारण एक बन्द प्रकार का तन्त्र या लूप सा बन जाता है। धमनी सबसे चौड़ी होती है और यह रुधिर को हृदय से शरीर के विभिन्न अंगों में पहुंचाती है। मनुष्य के धमनी तन्त्र को चित्र 18.8 में दिखाया गया है। धमनी विभक्त होकर पतली धमनिकाएं बनाती है। धमनिकाएं पुनः विभक्त होकर बहुत सी पतली केशिकाएं बनाती हैं।

केशिकाएं पतली वाहिकाएं होती हैं जिनकी भित्ति की मोटाई केवल एक कोशिका जितनी होती है। इनकी भित्ति पानी तथा छोटे-छोटे अणुओं, घुलित खाद्य पदार्थों तथा अपशिष्ट पदार्थों, ऑक्सीजन तथा कार्बन डाइऑक्साइड के लिए पारगम्य होती है जिनका केशिकाओं के आस पास

चित्र 18.8 मनुष्य में धमनी तन्त्र।

के ऊतकों में आदान प्रदान होता है। इन्हीं केशिकाओं के कारण फेफड़ों में स्थित कूपिकाएं हवा को लेती हैं तथा छोड़ती हैं और इन्हीं केशिकाओं के कारण ही यकृत में स्थित प्रत्येक केशिका रुधिर तथा पदार्थों के संवहन सम्पर्क में रहती हैं।

केशिकाएं आपस में जुड़कर लघु शिराएं बनाती हैं और अन्ततः शिरा बन जाती हैं। शिराएं रुधिर को वापिस हृदय में ले जाती हैं।

इस प्रकार हम देखते हैं कि धमनियाँ हृदय से रुधिर को शरीर के अन्य ऊतकों में केशिकाएं द्वारा ले जाती हैं तथा शिराएं रुधिर को ऊतकों से हृदय में वापस लाती है। रुधिर का प्रवाह एक ही दिशा में रखने के लिए धमनी तथा शिरा में वाल्व होते हैं। रुधिर प्रवाह का दाब उन्हें उसी दिशा में खोल देता है जिस ओर उसे बहना होता है। धमनी के रुधिर में ऑक्सीजन तथा घुलित खाद्य पदार्थ होते हैं जबकि शिरा के रुधिर में कार्बन डाइऑक्साइड तथा अपशिष्ट पदार्थ होते हैं। फुप्फुस धमनी तथा फुप्फुस शिरा इसके दो अपवाद हैं। इसका कारण आप चित्र 18.9 से पता कर सकते हैं।

चित्र 18.9 *मनुष्य का हृदय तथा इसके भाग।*

चित्र 18.9 में हृदय दिखाया गया है यह एक पंप की तरह होता है जो रुधिर का सारे शरीर में परिसंचरण करता है। इसमें चार कोष्ठक होते हैं — दांया तथा बांया आलिंद और दांया तथा बांया निलय। दांया तथा बांया भाग कपाट द्वारा विभाजित होता है तथा एक दूसरे से सम्पर्क नहीं रखता है। ऑक्सीजन युक्त रुधिर फुप्फुस शिरा द्वारा बांए आलिन्द में आता है। यहां से रुधिर द्विकपाट वाल्व की सहायता से बाएं निलय में आता है। निलय से रुधिर महाधमनी द्वारा सारे शरीर में चला जाता है। इसी प्रकार ऊतकों से अशुद्ध रुधिर महाशिरा द्वारा दाएं आलिंद में आता है। यहां से रुधिर त्रिकपाट वाल्व द्वारा दाएं निलय में आता है। यहां से रुधिर फुप्फुस धमनी द्वारा फेफड़ों में पुनः ऑक्सीजन युक्त होने के लिए चला जाता है। आराम करते हुए एक वयस्क में हृदय की पम्प करने की दर 70 प्रति मिनट है। व्यायाम करने या उत्तेजित होने पर यह दर बढ़ कर 150 तक हो सकती है। नीचे दिए गए क्रिया-कलापों से आप इस दर को माप सकते हैं।

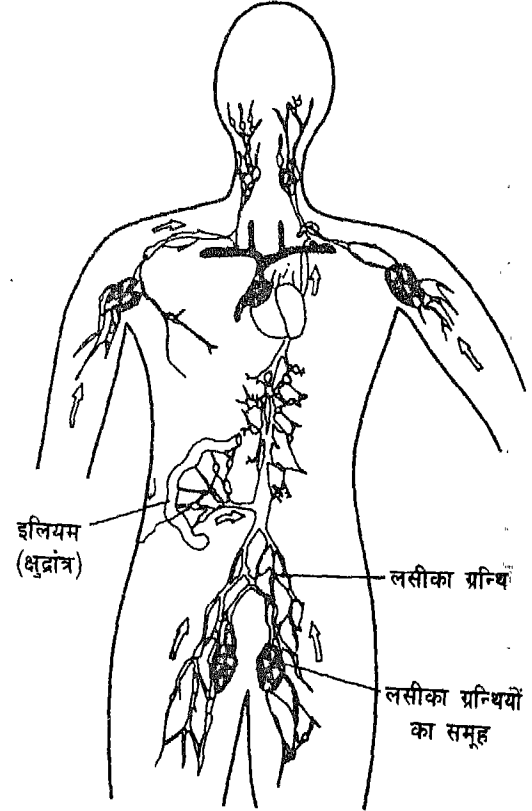
क्रियाकलाप — 5

हृदय से रुधिर के पम्प होने को शरीर के कुछ भागों पर अनुभव किया जा सकता है। कलाई में स्थित रुधिर वाहिकाएं इस कार्य के लिए बहुत उपयुक्त हैं। अपनी बायीं कलाई को अपने दाएं हाथ से पकड़ें और जैसे डाक्टर करता है उसी प्रकार अपनी कलाई को दबाएं। आप कुछ स्पंदन अनुभव करेंगे। जब आप आराम की अवस्था में हो तब स्पंदन दर गिनें और व्यायाम (2 मिनट दौड़ने के बाद) करने के बाद गिनें। देखिये दर कितनी बढ़ती है? यह भी देखिये कि स्पंदन दर कितने समय में सामान्य होती है। प्रायः आराम की अवस्था में स्पंदन दर 70-100 प्रति मिनट होती है और यह दर उत्तेजित होने पर दोगुनी हो जाती है।

कोशिकाओं में रुधिर को पहुंचने के लिए हृदय में अधिक दाब होना आवश्यक है। प्रवाहित रुधिर के उस दाब के अभाव में कोशिकाएं वैसे ही चपटी रह जाएंगी जैसे बिना हवा के गुब्बारा। रुधिर का यह दाब शरीर के विभिन्न भागों में भिन्न-भिन्न होता है। निलय जब सिकुड़ता है, रुधिर महाधमनी और फुप्फुस धमनी में चला जाता है तब एक सामान्य दाब उत्पन्न होता है। इस दाब को प्रकुंचन दाब कहते हैं।

प्रकुंचन दाब पारे के 120 mm स्तम्भ द्वारा बने दाब के बराबर होता है। इसके विपरीत की अवस्था अनुशिथिलन दाब होती है। इसमें रुधिर आलिंद से निलय में आता है। अनुशिथिलन दाब पारे के 80 mm स्तम्भ द्वारा बने दाब के बराबर होता है। आराम की अवस्था में एक वयस्क के स्वस्थ हृदय का दाब लगभग 120/80 होता है।

18.6 लसीका

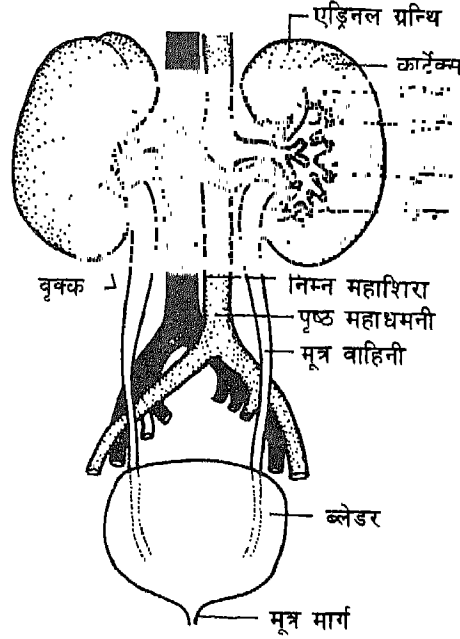
शरीर में लसीका एक अन्य परिसंचरण तंत्र है। प्रोटीन के अणुओं का साइज बड़ा होने के कारण वह पुनः कोशिकाओं में प्रवेश नहीं कर सकते। इसीलिए प्रोटीन के अणु लसीका में आ जाते हैं और यहां से वे रुधिर परिसंचरण में आते हैं। लसीका का रंग हल्का पीला होता है। इसमें हीमोग्लोबिन नहीं होता इसलिए इसका रंग लाल नहीं होता है। परन्तु इसकी रचना लगभग रक्त प्लाज्मा जैसी ही होती है। लसीका ऊतक से हृदय की ओर केवल एक ही दिशा में बहता है। इसमें विशेष प्रकार की सफेद कोशिकायें होती हैं जिन्हें **श्वेत कणिकाएं** (Lymphocytes) कहते हैं। ये कणिकाएं संक्रमण तथा रोगों के कीटाणुओं को मार देती है। चित्र 18.10 में मनुष्य के शरीर में लसीका तन्त्र के मार्ग को दिखाया गया है।

चित्र 18.10 मानव शरीर में लसीका तंत्र

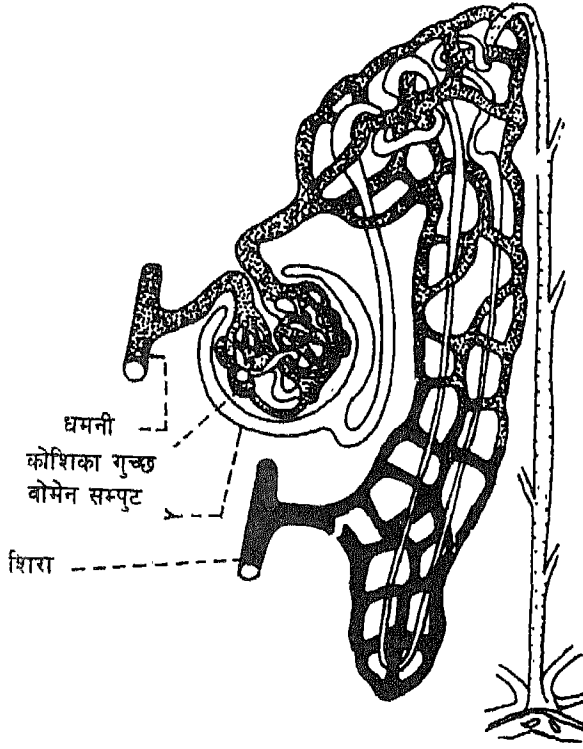
18.7 उत्सर्जन

भोजन के अंतर्ग्रहण तथा पाचन के बाद शरीर उपयोगी पदार्थों को विभिन्न ऊतकों तथा

कोशिकाओं में पहुंचाता है। अपाचित तथा अपशिष्ट पदार्थों को शरीर से बाहर निकालने की आवश्यकता होती है। शरीर में उपापचय की क्रियाओं द्वारा इन अपशिष्ट पदार्थों को बाहर निकालने की प्रक्रिया को **उत्सर्जन** (Excretion) कहते हैं। गैस, तरल तथा ठोस पदार्थों का उत्सर्जित होना आवश्यक है, और इन में से प्रत्येक के उत्सर्जन की प्रक्रिया भिन्न-भिन्न होती है। कार्बन डाइऑक्साइड सबसे प्रमुख अपशिष्ट पदार्थ है जिसे सांस द्वारा बाहर निकाला जाता है। श्वसन के समय कोशिकाओं में कार्बन डाइऑक्साइड रुधिर में स्थित हीमोग्लोबिन से मिलकर या पानी में घुलकर स्थानांतरित होती है। कार्बन डाऑक्साइड का निष्कासन फेफड़ों की सतह से होता है।

ठोस अपशिष्ट मुख्यतः भोजन का अपाचित भाग जैसे सब्जियों के रेशे (Roughage) होते है। स्मरण करें कि मुँह में भोजन का पाचन आरम्भ होता है तथा आमाशय में समाप्त होता है। पाचित भोजन पेट की भित्तियों द्वारा अवशोषित हो जाता है। अपाचित पदार्थ बड़ी आंत में आ जाता है और गुदा के रास्ते शरीर से निष्कासित हो जाता है। दिलचस्प बात यह है कि मुंह से लेकर गुदा तक एक ही रास्ता होता है।

अपशिष्ट तरल पदार्थों के उत्सर्जन के लिए एक जटिल क्रिया विधि की आवश्यकता होती है क्योंकि रुधिर में पोषक तत्व तथा अपशिष्ट पदार्थ दोनों ही होते हैं इसीलिए इनको छानने तथा अलग करने की विशेष विधि होती है। इस क्रिया से उपयोगी पदार्थ शरीर में ही रह जाते हैं और अपशिष्ट पदार्थ उत्सर्जित हो जाते हैं। यह क्रिया शरीर में स्थित वृक्कों द्वारा सम्पन्न होती है। शरीर में इनकी संख्या दो होती है। यदि इन में से एक वृक्क काम करना बन्द कर दे तो दूसरा वृक्क अकेले ही पूरा कार्य करता है।

चित्र 18.11(a) मनुष्य में वृक्क तथा उसकी सम्बन्धित संरचनाएं। दाएं वृक्क को आंशिक काटकर भीतरी संरचनाएं दिखाई गयीं हैं।

चित्र 18.11a में शरीर में वृक्क की स्थिति तथा वृक्क के कटे हुए एक भाग को दिखाया गया है। वृक्क-धमनी, महाधमनी से रुधिर लेकर वृक्क में पहुंचाती है। अपशिष्ट पदार्थ अलग करने के बाद साफ रुधिर वृक्क-शिरा द्वारा वापिस भेज दिये जाते हैं। वृक्क द्वारा अलग किए गए अपशिष्ट पदार्थ को मूत्र कहते हैं। मूत्र मूत्र वाहिनी से मूत्राशय में जाता है और मूत्र मार्ग से उत्सर्जित हो जाता है।

चित्र 18.11 (b) मनुष्य की केशिका जालियां तथा केशिका गुच्छ की रचना का विवरण।

वृक्क सेम के आकार का होता है। वृक्क के भीतर वृक्क–धमनी कई लाख केशिकाओं में विभाजित हो जाती है। प्रत्येक केशिका पुनः बार-बार विभाजित होती है और कुंडलित हो जाती है। इन संरचनाओं को केशिका गुच्छ कहते हैं। इनकी भित्तियों से रुधिर छन जाता है। छना हुआ तरल या सीरम छोटे-छोटे प्यालों या बोमन संपुट में एकत्र हो जाता है। इस छने हुए तरल में ग्लूकोस, लवण तथा नाइट्रोजन के यौगिक होते हैं। प्रोटीन रुधिर में ही रह जाती है। इस प्रक्रिया को, जिसमें छोटे अणु छन कर बाहर आ जाते हैं तथा प्रोटीन जैसे बड़े अणु बाहर नहीं आ पाते, अपोहन (डायलिसिस) कहते हैं। वृक्क में स्थित केशिका गुच्छ डायलिसिस थैली का कार्य करता है।

मूत्र मार्ग में आने से पहले छना हुआ तरल बहुत ही महीन नलियों में से गुजरता है। इन नलियों में ग्लूकोस, तथा अन्य उपयोगी पदार्थ पुनः अवशोषित हो जाते हैं। अवशोषित पदार्थ वृक्क–शिरा में स्थित रुधिर में वापिस आ जाते हैं। अपशिष्ट तरल जिसे मूत्र कहते हैं निष्कासन के लिए मूत्राशय में आ जाता है। निम्न क्रिया कलाप से आपको डायलिसिस का सिद्धान्त तथा उसका उपयोग का पता लग जायेगा।

क्रियाकलाप–6

एक कोलोडियन (Collodion) या सेलोफोन की थैली लें। उसमें स्टार्च तथा नमक के घोल की समान मात्रा भरें। थैली के सिरे को धागे से बांध दें (जैसा की आप गुब्बारे में करते हैं) और थैली को आसुत जल से भरे बीकर में लटका दें। इसे कई घण्टे तक ऐसे ही रहने दें। इसके बाद बीकर वाले पानी का सोडियम क्लोराइड (सिल्वर नाइट्रेट का तनु घोल क्लोराइड की उपस्थिति में दूधिया हो जाएगा) तथा स्टार्च के लिए (आयोडीन डालकर) परीक्षण करें। आप देखेंगे कि सोडियम क्लोराइड के कण थैली से बाहर आ जाते हैं जब कि स्टार्च के नहीं। कोलोडियन थैली में छिद्र इतने बड़े थे कि उसमें से सोडियम तथा क्लोराइड के आयन आसानी से बाहर निकल आए, लेकिन वही छिद्र स्टार्च के बड़े अणुओं के लिए छोटे रह गए। कोलोडियन झिल्ली इस प्रकार अर्ध पारगम्य है और यह अणुओं के विशेष साइज का विभेदीकरण

करती है।

डायलिसिस सिद्धान्त का उपयोग कृत्रिम वृक्क बनाने में किया जाता है। यदि प्राकृतिक वृक्क खराब हो जाए तब डाक्टर उस वृक्क को निकाल देते हैं और किसी स्वस्थ मनुष्य द्वारा दान दिये गये दूसरे वृक्क को प्रतिरोपित कर देते हैं अथवा कृत्रिम वृक्क का उपयोग करते हैं। इसमें किसी एक धमनी से रोगी के रुधिर को एक सेलोफेन नली में लाते हैं। जो कि नमक के घोल में लटकी रहती है। यह नमक का घोल ऐसा बनाया जाता है कि इसका संघटन रुधिर प्लाज्मा के समान हो। जब रुधिर सेलोफेन नली में से गुजरता है तो अपशिष्ट पदार्थों के छोटे अणु जैसे अमोनिया तथा यूरिया नली से बाहर निकल कर घोल में आ जाते हैं और बड़े अणु जैसे प्रोटीन रुधिर में ही रह जाते हैं। इस प्रकार कई बार डायलिसिस करने के बाद साफ रुधिर को रोगी की शिराओं में वापिस भेज दिया जाता है।

प्रश्नावली

1. पोषण की परिभाषा दीजिए। पोषण के विभिन्न प्रकार क्या हैं?
2. परपोषी जीव किस प्रकार स्वपोषी जीवों पर निर्भर करते हैं?
3. निम्नलिखित में अंतर बताइए:
   (अ) मृतजीवी तथा परजीव पोषण
   (ब) प्रकाश संश्लेषण तथा श्वसन
   (स) आक्सी तथा अनाक्सी श्वसन
4. मुंह से लेकर कोशिका में अवशोषित होने तक भोजन में जो परिवर्तन होते हैं उनके विभिन्न पाचन चरण लिखिये।
5. प्रकाश संश्लेषण में संतुलित प्रकाश तीव्रता क्या है?
6. क्या श्वसन तथा सांस लेना एक ही क्रिया है? यदि नहीं, तो क्यों नहीं? क्या श्वसन तथा जलना एक ही क्रिया है? यदि नहीं, तो क्यों नहीं?
7. पत्तियों में स्थित स्टोमेटा का खुलना तथा बन्द होना कैसे नियमित होता है?
8. ऊंचे-ऊंचे वृक्षों में पानी ऊपर कैसे चढ़ जाता है?
9. चित्र 18.5 देखो जिसमें रेडियो धर्मी कार्बन डाइआक्साइड को रेडियो धर्मी स्टार्च में स्थिर किया गया है। क्या आप बता सकते हैं कि इसमें स्टार्च बनाने के लिए कार्बन डाइआक्साइड कार्बन के स्रोत के रूप में काम करता है अथवा ऑक्सीजन के? इसे समझाइये।

10. रेखाचित्र द्वारा निम्न चरणों को दर्शाइये–
    (1) ग्लूकोस के अणु उस समय से जब यह छोटी आंत (इलियम) में अवशोषण लिए तैयार हैं, और
    (2) फेफड़ों में ऑक्सीजन अणु का अवशोषण, उस समय तक जब ये दोनों टांग की पेशी कोशिका में पहुंचते हैं।
11. रुधिर के कौन-कौन से घटक हैं और प्रत्येक का क्या कार्य है?
12. रुधिर प्रवाह के लिए पतली तथा शाखित कोशिकाओं का होना क्यों लाभदायक है?
13. प्रत्येक कथन के आगे सही या गलत का चिह्न लगाइये। यदि कथन गलत है तो उसे ठीक कीजिए।
    (1) आलिंद की दीवारें निलय से मोटी होती हैं।
    (2) ऑक्सीजन युक्त रुधिर बायें आलिंद में आता है।
    (3) वाल्व दोनों ओर खुलते हैं।
    (4) जाइलम भोज्य पदार्थों का संवहन करता है।
    (5) मनुष्य में रुधिर परिसंचरण खुले तंत्र द्वारा होता है।
14. किसी पौधे में उत्सर्जन कैसे होता है?
15. पौधों तथा मनुष्यों के विभिन्न अपशिष्ट पदार्थ कौन से हैं?
16. वृक्क में केशिका गुच्छ के क्या कार्य हैं?

जैव-प्रक्रियाएं – II

भूमिका

वृद्धि सभी सजीवों की एक आवश्यक प्रक्रिया है। वृद्धि उपापचयी क्रिया के कारण होती है। इस प्रक्रिया के समय नए-नए जैव रासायनिक यौगिक बनते हैं जिनका उपयोग बहुत-सी प्रक्रियाओं में होता है। जब किसी जीव में वृद्धि होती है तब उसका आकार, माप तथा भार स्थायी तथा अपरिवर्तनीय रूप में बढ़ता है। आरम्भिक अवस्थाओं में शरीर के भार में कमी भी हो सकती है जैसा कि अंकुरित बीजों में होता है। परंतु जब नवोद्भिद् वृद्धि करता है तब उसका भार पुनः बढ़ता है। वृद्धि के दौरान केवल माप में ही परिवर्तन नहीं आता बल्कि विभेदन भी होता है। जन्तुओं तथा पौधों में वृद्धि होती है। लेकिन दोनों की वृद्धि में कुछ अन्तर होता है। इसके कुछ अन्तर तालिका 19.1 में दिए गए हैं।

तालिका – 19.1

पौधों तथा जन्तुओं में वृद्धि

पौधे	जन्तु
पौधों में सारा जीवन निरन्तर वृद्धि होती रहती है पौधे में वृद्धि क्षेत्र होते हैं। ये क्षेत्र प्रायः जड़ तथा तने के अग्रिम भाग हैं	जन्तुओं की वृद्धि एक निश्चित समय में होती है। सारे शरीर में समान रूप से वृद्धि होती है।
पौधों में वृद्धि विभाज्योतक ऊतकों की उपस्थिति के कारण होती है।	जन्तुओं में विभाज्योतक ऊतक नहीं होते

अमीबा, **पैरामीशियम**, **युग्लीना** या जीवाणु जैसे एक कोशीय जीवों में वृद्धि का अर्थ है पदार्थ संश्लेषण तथा कोशिका साइज में वृद्धि होना। यह प्रक्रिया माइटोटिक कोशिका विभाजन से होती है जैसा कि आपने अध्याय 17 में पढ़ा है।

उच्चवर्गीय स्पीशीज में नर तथा मादा युग्मों में मिलने से एक युग्मनज बनता है। युग्मक अपने आप में मिऑटिक विभाजन से बनते हैं। (देखें अध्याय 17 अनुभाग 4)। युग्मनज से वृद्धि

आरम्भ होती है और यह वृद्धि एक क्रम में होती है। इस वृद्धि के क्रम की विभिन्न अवस्थाएं इस प्रकार हैं:–

1. **कोशिका विभाजन**:– कोशिका सबसे पहले पानी तथा भोजन अवशोषित करती है और परिपक्व हो जाती है। यह कोशिका बार-बार विभाजित होकर नई-नई कोशिकाएं बनाती है।

2. **कोशिका दीर्घीकरण**:– इस अवस्था में कोशिका की लम्बाई बढ़ती है।

3. **कोशिका-परिपक्वता**:– इस प्रक्रिया में रासायनिक तथा भौतिक परिवर्तन होने के कारण कोशिका में विभेदन हो जाता है। उनकी आकृति तथा साइज स्थायी हो जाती है। ऐसी कोशिकाओं से विभिन्न ऊतक तथा अंग बनते हैं।

आरम्भिक अवस्था में वृद्धि की दर कम होती है लेकिन उसके तुरन्त बाद यह दर बढ़ जाती है। अन्तिम अवस्था के पहुंचने तक वृद्धि की दर में निरन्तर वृद्धि होती रहती है। वृद्धि तथा विभेदन की बहुत सी अवस्थाएं हार्मोनों जैसे रासायनिक पदार्थों के विशेष नियंत्रण में होती हैं। हार्मोन की मात्रा बहुत ही कम होती है, ये उत्पन्न होने वाले स्थान से स्थानान्तरित होकर क्रिया करने वाले स्थान तक परिवहन करते हैं। इसी अध्याय में हम हार्मोन के विषय में अधिक विस्तार से पढ़ेंगे।

19.1 जनन

जनन जीवधारियों का एक बहुत ही महत्वपूर्ण गुण है। इस प्रक्रिया में जीवों की एक पीढ़ी दूसरी पीढ़ी को जन्म देती है। जीवन की उत्पत्ति से लेकर आज तक जीवन की निरन्तरता जीवों के जनन के ही कारण बनी हुई है। जीवधारियों का अपना तथा अपनी स्पीशीज का परिरक्षण करना एक महत्वपूर्ण तथा अदभुत गुण है। कोई स्पीशीज जैसा कि अध्याय 17 में बताया गया है परस्पर सम्बन्धित पौधों अथवा जन्तुओं का एक वर्ग है जो संतति उत्पन्न करने के लिए संकरण करते हैं। स्पीशीज का परिरक्षण इसलिए संभव हो पाया है क्योंकि माता-पिता अपनी ही तरह की सन्ततियों को उत्पन्न करते हैं। किसी स्पीशीज की जनसंख्या बढ़ाने का भी जनन एक साधन है। जनन विकास में भी एक महत्वपूर्ण भूमिका निभाता है, इस दौरान जीव अपने अनुकूल विविधताओं को एक पीढ़ी से दूसरी पीढ़ी में स्थानान्तरित करता है। सजीव में दो प्रकार का जनन होता है। (1) अलैंगिक जनन तथा (2) लैंगिक जनन।

19.2 अलैंगिक जनन

इस प्रकार के जनन में दो लिंगों की आवश्यकता नहीं होती। इसमें जीव स्वयं गुणित होते हैं। अलैंगिक जनन की विभिन्न विधियां इस प्रकार हैं:–

1. **विखंडन**:– जब जीव पूर्ण विकसित होता है तब यह दो भागों में विभाजित हो जाता है इसे विखंडन कहते हैं। पहले केन्द्रक विभाजित होता है और फिर कोशिका द्रव्य। विखंडन से जब दो जीव बनते हैं तो उस प्रक्रिया को द्विखंडन कहते हैं। चित्र 19.1 a में अमीबा में द्विखंडन विधि को दिखाया

गया है। इससे दो संतति कोशिकाएं बनती हैं। क्या आप अनुमान लगा सकते हैं कि नई पीढ़ी को संतति क्यों कहते हैं?

कभी-कभी प्रतिकूल परिस्थितियों में कोशिका के चारों ओर एक सरंक्षक परत या भित्ति बन जाती है। ऐसी अवस्था को **पुटी** (सिस्ट) कहते हैं। पुटी के अन्दर कोशिका कई बार विभाजित हो जाती है जिससे बहुत सी संतति कोशिकाएं बन जाती हैं। ऐसी प्रक्रिया को बहुखंडन कहते हैं। पुटी के फटने के बाद बहुत सी कोशिकाएं बाहर निकल जाती हैं। इसी विधि को चित्र 19.1b में दिखाया गया है।

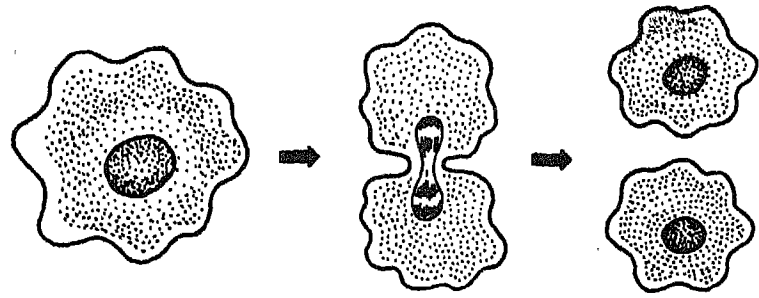
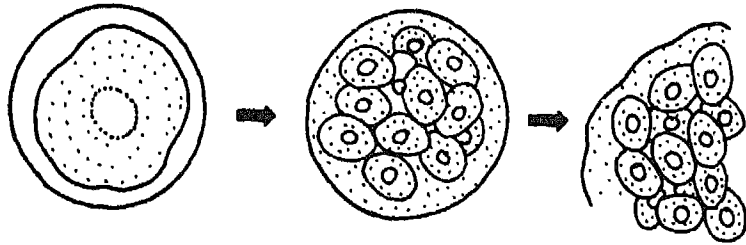
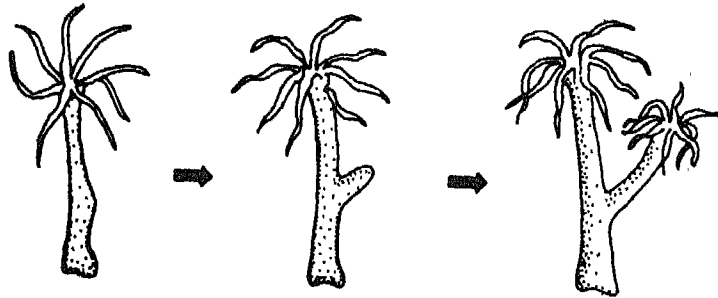
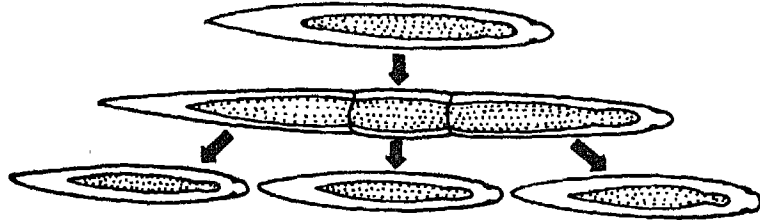
2. **मुकुलन**:– शरीर पर एक बल्ब की तरह की संरचना बनती है जिसे मुकुल कहते हैं। शरीर का केन्द्रक दो भागों में विभाजित हो जाता है और उनमें से एक केन्द्रक मुकुल में आ जाता है। मुकुल पैतृक जीव से अलग होकर वद्धि करता है और पूर्ण विकसित जीव बन जाता है उदाहरणतः यीस्ट तथा हाइड्रा (चित्र 19.1 c)।

3. **खंडन**:–**स्पाइरोगायरा** जैसे कुछ जीव पूर्ण विकसित होने के बाद साधारणतः दो या अधिक खण्डों में टूट जाते हैं। ये खंड वृद्धि करके पूर्ण विकसित जीव बन जाते हैं। चित्र 19.1d में खंडन विधि द्वारा किसी चपटे कृमि से दो चपटे कृमि को बनता हुआ दिखाया गया है।

4. **बीजाणुओं द्वारा**:– कुछ जीवाणु तथा निम्न वर्गीय जीव बीजाणु विधि द्वारा जनन करते हैं। बीजाणु कोशिका की विरामी अवस्था है जिसमें प्रतिकूल परिस्थिति में कोशिका की रक्षा के लिए उसके चारों ओर एक मोटी भित्ति बन जाती है। अनुकूल परिस्थिति में मोटी भित्ति टूट जाती है और जीवाणु सामान्य विधि से जनन करता है और वृद्धि करके पूर्ण विकसित जीव बन जाता है। इस विधि द्वारा जनन करने के कुछ उदाहरण हैं—म्यूकर, फर्न अथवा मॉस।

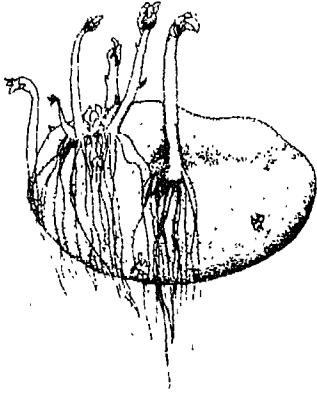
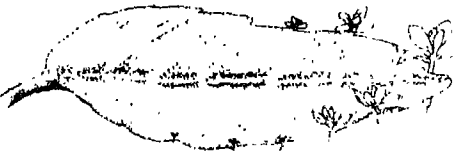
5. **कायिक प्रवर्धन**:– आपने देखा होगा कि माली गुलाब की एक टहनी लेकर उसे जमीन में गाड़ देता है। अनुकूल परिस्थिति में इस टहनी से गुलाब का नया पौधा बन जाता है। पौधे के किसी भी कायिक अंग जैसे पत्ता, तना अथवा जड़ का उपयोग नया पौधा तैयार करने में कर सकते हैं। इस प्रक्रिया को कायिक प्रवर्धन कहते हैं। इस विधि का उपयोग प्रायः उच्च वर्गीय पौधों विशेषतः उद्यान में लगाने वाले तथा फल देने वाले पौधों में किया जाता है। पौधों में कायिक प्रवर्धन एक सामान्य विधि है।

उदाहरणतः अमरूद अथवा शकरकंद अथवा पौदीने (चित्र 19.2 a) की छोटी–छोटी जड़ों पर अपस्थानिक कलियां होती हैं। ये कलियां अनुकूल परिस्थितियों में वृद्धि करके पूर्ण विकसित पौधा बना देती हैं।

अन्य पौधों में उनकी शाखाएँ कुछ दूरी तक उगती हैं और उसके बाद उनमें भूमि की ओर

चित्र 19.1 (a) अमीबा में द्विखंडन। (b) पुटि बनना तथा कोशिकाओं का परजीवी में निकलना। (c) हाइड्रा में मुकुलन। (d) स्पाइरोगाइरा में खंडन।

चित्र 19.2 पत्तियों के मुकुलन से पोदीने का नया पौधा बनना, कक्ष का बनना तथा आलू के वायवीय प्ररोह का निकास, पत्तियों में मुकुलन तथा ब्रायोफिलम का नया पौधा बनना।

अपस्थानिक जड़ें और ऊपर की ओर पत्तियां निकलती हैं। आलू की शल्की पत्तियों के कक्ष में कलियां होती है। इन कलियों से वायवीय प्ररोह विकसित हो जाते हैं (चित्र 19.2b)। इस के अन्य उदाहरण हैं अदरक, हल्दी, प्याज, केला, लहसुन तथा जलकुम्भी।

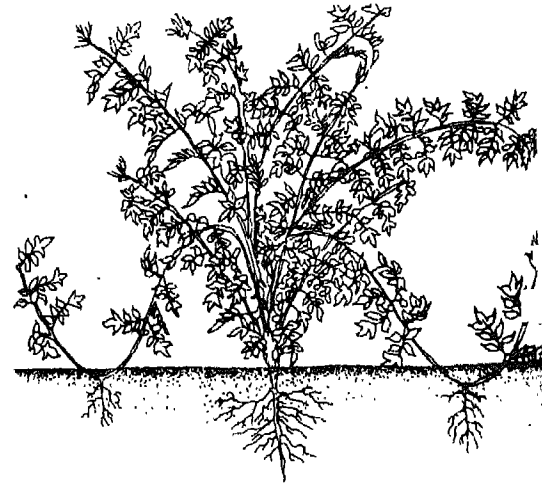
पत्तियाँ :– ब्रायोफिलम की पत्तियों के किनारों पर स्थित खांचों में अपस्थानिक कलियां होती हैं। अनुकूल परिस्थितियों में कलियां वृद्धि करके पूर्ण विकसित पौधा बना देती हैं (चित्र 19.2 c)।

मनुष्य ने पौधों में कायिक प्रवर्धन विधि का उपयोग अपने लाभ के लिए किया है। इससे वह उद्यानों तथा नर्सरी में नए-नए पौधे उगा सकता है। कायिक प्रवर्धन में आजकल रोपण, कलम, दाब कलम तथा ऊतक संवर्धन जैसी विधियां अपनाई जाती हैं।

रोपण :– इस विधि में हम ऐच्छिक पौधे की टहनी (कलम) को किसी अन्य वृक्ष के ठूंठ (स्कन्ध) पर लगा देते हैं। स्कन्ध पौधे का वह भाग होता है जिसके तने पर मिट्टी के नीचे पूरा मूल-तंत्र होता है। कलम ऐच्छिक पौधे की टहनी होती है। दोनों भागों को बांध देते हैं (चित्र 19.3)। कैम्बियम की प्रक्रिया के कारण कलम तथा स्कन्ध एक दूसरे से जुड़ जाते हैं। स्कन्ध कलम को पोषण प्रदान करता है। इस विधि को अपनाने से हम ऐच्छिक गुणों वाले पौधे तथा फल प्राप्त कर सकते हैं। आम की बहुत सी किस्में रोपण विधि से ही प्राप्त की जा सकती हैं।

चित्र 19.3 तने की कलम द्वारा रोपना।

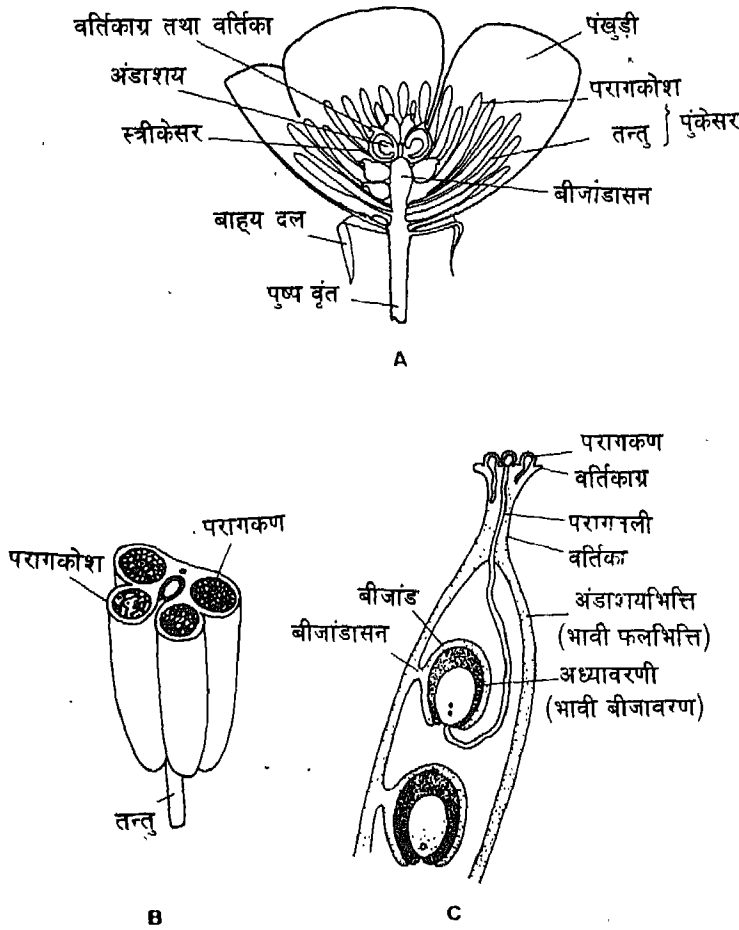
कलम लगाना :– यदि हम गुलाब के पौधे की कलम काटकर नम मिट्टी में लगा दें तो इसमें जड़ें निकल आती हैं और बाद में वृद्धि करके नया पौधा बन जाता है। कलम लगाते समय यह ध्यान रखना चाहिए कि उसमें कुछ कलिकाएँ अवश्य हों। कलम लगाने की विधि का उपयोग बोगेनविलिया, गन्ना, कैक्टस तथा अन्नानास उगाने में किया जाता है।

दाब कलम :– इस विधि में पौधे की किसी शाखा को झुका कर नम मिट्टी में दबा देते हैं। कुछ समय बाद इससे जड़ें निकल आती हैं और उसके बाद नयी पौध बन जाती है। नयी पौध को इसके पैतृक पौधे से काटकर अलग कर देते हैं। नयी पौध वृद्धि करके पूर्ण विकसित पौधा बन जाता है। चित्र 19.4 में दाब कलम से चमेली के पौधे बनाना दिखाया गया है।

ऊतक संवर्धन :– इस विधि में पौधे के ऊतक के एक छोटे से भाग को काट लेते हैं। इस ऊतक को उचित परिस्थितियों में पोषक माध्यम में रखते हैं। ऊतक से एक अनियमित ऊर्ध्व सा बन जाता है जिसे **कैलस** कहते हैं। कैलस का उपयोग पुन: गुणन में किया जाता है। इस ऊतक का छोटा सा भाग किसी अन्य माध्यम में रखते हैं जो पौधे में विभेदन की प्रक्रिया को उत्तेजित करता है। इस पौधे को गमलों या भूमि में लगा देते हैं और उस को परिपक्व होने तक वृद्धि करने दिया जाता है। ऊतक संवर्धन से आजकल आर्चिड, गुलदाउदी, शतावरी तथा बहुत से अन्य पौधे तैयार किए जाते हैं।

कायिक प्रवर्धन द्वारा तैयार किए गए पौधों में बीज से उगाए जाने वाले पौधों की अपेक्षा फूल तथा फल जल्दी उगते हैं। इस विधि द्वारा हम बीज रहित फल भी प्राप्त कर सकते हैं। कायिक प्रवर्धन द्वारा उगाए गए पौधे अपने पैतृक पौधों के बिल्कुल समान होते हैं उनमें कोई भी अन्तर नहीं होता। परंतु इससे उनमें वातावरण से अनुकूलित होने की क्षमता कम हो जाती है।

चित्र 19.4 दाबकलम से चमेली का नया पौधा उत्पन्न करना।

19.3 लैंगिक जनन

इस प्रकार के जनन में नर तथा मादा दोनों ही भाग लेते हैं। शिशु दो विशेष कोशिकाओं के मिलने से बनता है जिन्हें युग्मक कहते हैं। प्रायः उनमें से एक युग्मक दूसरे युग्मक की अपेक्षा अधिक सक्रिय तथा छोटा होता है। सक्रिय तथा छोटा युग्मक नर से प्राप्त होता है इसे शुक्राणु कहते हैं। दूसरा युग्मक जो निष्क्रिय तथा बड़ा होता है मादा से आता है और इसे अंडाणु कहते हैं। यदि कोई जीव केवल शुक्राणु उत्पन्न करे तो उसे नर कहते हैं। यदि कोई जीव केवल अंडाणु उत्पन्न करे तो उसे मादा कहते हैं।

चित्र 19.5 (a) बटर-कप फूल के विभिन्न भाग (b) परागकोश की रचना (शीर्ष कटा हुआ) (c) निषेचन

बहुत-सी स्पीशीज जैसे मनुष्य में नर तथा मादा दोनों स्पष्टतया भिन्न होते हैं। लेकिन कुछ स्पीशीज जैसे केंचुआ तथा हाइड्रा में एक ही जीव नर तथा मादा दोनों युग्मकों को उत्पन्न करता है। ऐसे जीवों को **उभयलिंगी या द्विलिंगी** कहते हैं। लेकिन ये उभयलिंगी जीव एक ही समय में या तो नर युग्मक उत्पन्न करते हैं या मादा युग्मक। इस प्रकार एक समय में ये एक लिंगी जैसे नर या मादा के रूप में ही काम करते हैं। इसलिए इन जन्तुओं में भी जनन के लिए अलग-अलग नर तथा मादा की आवश्यकता होती है। इनमें से एक युग्मक नर से आता है तथा दूसरा मादा से। नर युग्मक को शुक्राणु तथा मादा युग्मक को अंडाणु कहते हैं। लैंगिक जनन एक कोशिकीय तथा बहुकोशिकीय दोनों जीवों में होता है। बहुकोशिकीय जीवों में लैंगिक जनन बहुत ही सामान्य है।

पौधों में लैंगिक जनन

फूल, पौधे का जनन अंग होता है। चित्र 19.5 में फूल में जनन अंगों को दिखाया गया है। जैसे– आप जानते हैं कि इसमें **पुंकेसर** नर तथा **स्त्री केसर** मादा जनन अंग हैं। पुंकेसर के अग्र भाग पर परागकोश होते हैं। परागकोश में पराग कण होते हैं। पराग कण छोटी-छोटी संरचनाएं होती हैं। ये नर युग्मक बनाते हैं। स्त्रीकेसर का आधार चौड़ा होता है और ऊपर जाते-जाते पतला होता जाता है। निचले चौड़े आधार को अंडाशय कहते हैं। इसमें अंडाणु होते हैं। अंडाणु में बीजांड होते हैं। स्त्रीकेसर के ऊपरी भाग को वर्तिका कहते हैं। वर्तिका का अग्रभाग चिपचिपा होता है। इसे वर्तिकाग्र कहते हैं। परागकण, हवा, पानी या कीटों द्वारा स्त्रीकेसर के वर्तिकाग्र पर पहुंच जाते हैं। परागकोश से परागकण वर्तिकाग्र पर स्थानान्तरित हो जाते हैं तब ऐसी प्रक्रिया को **परागण** कहते हैं। परागण के बाद परागकण से एक परागनली निकलती है। परागनली में दो नर युग्मक होते हैं। इनमें से एक नर युग्मक पराग नली में से होता हुआ बीजांड तक पहुंच जाता है। यह बीजांड के साथ संलयित हो जाता है जिससे एक युग्मनज बनता है। ऐसे संलयन को **निषेचन** कहते हैं। युग्मनज माइटोटिक विधि द्वारा कई बार विभाजित होता है जिससे अन्ततः एक नया पौधा बन जाता है। चित्र 19.5 द्वारा पौधे में निषेचन प्रक्रिया का वर्णन किया गया है।

निषेचन के बाद फूल के पंखुड़ी, पुंकेसर, वर्तिका, तथा वर्तिकाग्र गिर जाते हैं। बाह्य दल सूख जाता है पर अंडाशय से लगा रहता है। अंडाशय शीघ्रता से वृद्धि करता है। इसमें स्थित कोशिकाएं विभाजित हो कर वृद्धि करती हैं और बीज का बनना आरम्भ हो जाता है। बीज में एक पौधा अथवा भ्रूण उत्पन्न करने की क्षमता होती है। भ्रूण में एक छोटी जड़ (मूलज), एक छोटा प्ररोह (प्रांकुर) तथा बीजपत्र होते हैं। बीजपत्र में भोजन संचित रहता है। समयानुसार बीज सख्त होकर सूख जाता है। यह बीज प्रतिकूल परिस्थिति में भी जीवित रह सकता है। अंडाशय की दीवार या तो कड़ी हो जाती है और एक फली बन जाती है जैसे खसखस में अथवा एक गूदेदार रसीला फल बन सकती है जैसे आलूबुखारा अथवा टमाटर में। निषेचन के बाद सारे अंडाशय को फल कहते हैं।

जन्तुओं में लैंगिक जनन

जन्तुओं में लैंगिक जनन विभिन्न विधियों द्वारा

होता है। लैंगिक जनन के समय **मोनोसिस्टिस** जैसे एक कोशिकीय जीव आकार तथा साइज में समान होते हैं। मलेरिया परजीवी में दोनों जीव असमान होते हैं। बहुकोशिकीय जीवों में नर शुक्राणु तथा मादा अंडा उत्पन्न करती है। उभयलिंगी जीवों में एक ही जीव एक समय में शुक्राणु उत्पन्न करता है तो दूसरे में अंडा।

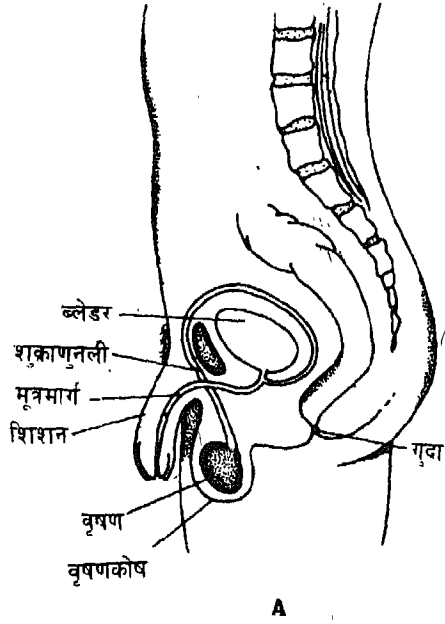
मेंढक में नर तथा मादा दोनों जीव संभोग करते हैं और अपने-अपने युग्मकों को पानी में छोड़ देते हैं। शुक्राणु अंडों को पानी में ही निषेचित करता है। ऐसे निषेचन को बाह्य निषेचन कहते हैं।

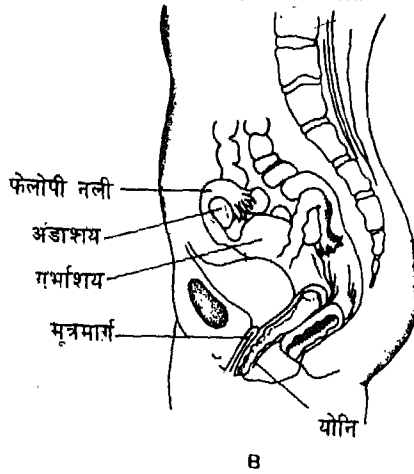
मवेशी, कुत्ता, कीट, मकड़ी, मनुष्य तथा ऐसे ही अन्य जन्तुओं में नर अपने शुक्राणु को मादा के शरीर के अन्दर छोड़ते हैं। शुक्राणु अंडों को मादा के शरीर के अन्दर ही निषेचित करते हैं। ऐसे निषेचन को आन्तरिक निषेचन कहते हैं। निषेचन के फलस्वरूप युग्मनज बनता है। निषेचन के तुरन्त बाद युग्मनज विकसित होना आरम्भ कर देता है। युग्मकों में अपने माता-पिता की तुलना में आधी संख्या में गुण सूत्र (क्रोमोसोम) होते हैं। निषेचन से जब दो युग्मक जिनमें आधी संख्या में क्रोमोसोम होते हैं, मिलते हैं तब जीव में क्रोमोसोम की संख्या पूरी हो जाती है।

मनुष्य में जननतंत्र

मनुष्य में जनन अंग मादा में 12 से 13 वर्ष की आयु में तथा नर में 15 से 18 वर्ष की आयु में प्रायः क्रियाशील हो जाते हैं। जनन अंग भी कुछ हॉर्मोन स्रावित करते हैं जो शरीर में परिवर्तन लाते हैं। ऐसे परिवर्तन मादा में प्रायः वक्ष तथा जनन अंगों पर बाल उगने से परिलक्षित होते हैं। नर में ये परिवर्तन जननांगों पर बाल उगने, दाढ़ी तथा मूछें आने से परिलक्षित होते हैं।

चित्र 19.6 a में नर के जनन अंगों को दिखाया गया है। ग्रन्थि जिसे **वृषण** कहते हैं एक जोड़ी होते हैं। ये वृषण पेशीय थैले जिसे वृषण कोष कहते हैं, में स्थित होते हैं। प्रत्येक वृषण से एक नली निकलती है तथा दोनों मिलकर एक नली में खुलते हैं जिसे मूत्र मार्ग कहते हैं। मूत्र मार्ग एक पेशीय अंग से निकलता है जिसे **शिश्न** कहते हैं। शिश्न में बहुत अधिक मात्रा में रुधिर प्रवाहित होता है और इसकी पेशियां भी विशेष प्रकार की होती हैं जो शिश्न को कभी कभी सख्त भी बना देती हैं। शिश्न का उपयोग मूत्र करने तथा नर जनन कोशिकाओं अर्थात् शुक्राणुओं को निकालने में किया जाता है। शुक्राणु वृषण में उत्पन्न होते हैं और वही पर संचित रहते हैं। विशेष संरचना जिसे शुक्राशय कहते हैं,वृषण में शुक्राणु के पोषण के लिए विशेष तरल छोड़ती है। शिश्न शुक्राणुओं को मादा जनन अंगों में छोड़ देता है।

मादा के जनन तन्त्र में अंडाशय, अंडवाहिनी, योनि तथा भग होते हैं (चित्र 19.6b)। उदरीय गुहिका में एक जोड़ी **अंडाशय** होते हैं। अंडाशय के पास से **अंडवाहिनी** एक कीप की तरह शुरू होती है तथा एक पतली तथा कुंडलित **डिम्ब वाहिनी** नलिका तक जाती है। दोनों ओर की डिम्ब वाहिनी नलिका जुड़कर एक बड़ा कोष्ठ बनाती है जिसे **गर्भाशय** कहते हैं। गर्भाशय एक कोष्ठ में खुलता है जिसे **योनि** कहते हैं। योनि बाहर की ओर एक छिद्र से खुलती है जिसे **भग** कहते हैं। **उत्सर्जन नलिका** (मूत्रवाहिनी) एक

चित्र 19.6 (a) पुरूष का जनन तंत्र।

अन्य अलग छिद्र से बाहर की ओर खुलती है। परिपक्वता के बाद अंडाशय प्रति 28 दिन के

चित्र 19.6 (b) स्त्री का जनन तंत्र।

बाद एक अंडा छोड़ता है। अंडे के छोड़ने की प्रक्रिया को **अंडोत्सर्ग** कहते हैं। अंडोत्सर्ग से पहले गर्भाशय अंडे को ग्रहण करने के लिए अपने को तैयार करता है। इस कार्य के लिए गर्भाशय की कोशिकीय अन्तःस्तर जिसमें रुधिर वाहिकाएं होती हैं, गिर जाता है और उसके स्थान पर नया अन्तःस्तर बन जाता है। यह प्रक्रिया 3-4 दिन तक चलती है और इस प्रक्रम में रुधिर निकलता है। इस प्रक्रिया को **रजोधर्म** कहते हैं। रजोधर्म के 12-14 दिन बाद **अंडोत्सर्ग** होता है। गर्भाशय में अंडा चौदहवें दिन आता है और शुक्राणु की प्रतीक्षा सोलहवें दिन तक करता है। यदि इसे शुक्राणु नहीं मिलता तो यह विघटित होना आरम्भ हो जाता है। अठ्ठाइसवें दिन के बाद यह अंडा तथा गर्भाशय का अन्तःस्तर रजोधर्म के रूप में बाहर निकाल दिया जाता है। यदि अंडे से शुक्राणु मिल जाता है तो एक **युग्मनज** बन जाता है। युग्मनज गर्भाशय की दीवार पर चिपक जाता है और भ्रूण बनना आरम्भ कर देता है। गर्भाशय की दीवार के ऊतकों तथा भ्रूण के ऊतकों के एक दूसरे से जुड़ने के कारण युग्मनज गर्भाशय की दीवार से आसानी से चिपक जाता है। अब मादा को गर्भवती कहते हैं।

युग्मनज के गर्भाशय की दीवार से चिपकने से भ्रूण तथा मादा में एक सम्बन्ध स्थापित हो जाता है। इस जुड़ने को **प्लेसैन्टा** कहते हैं। जब भ्रूण बन जाता है और वह गर्भाशय की दीवार पर चिपक जाता है तब रजोधर्म तथा अंडोत्सर्ग बंद हो जाते हैं। बच्चा पैदा होने के बाद रजोधर्म तथा अंडोत्सर्ग पुनः आरंभ हो जाते हैं। मनुष्य में नर सारा जीवन शुक्राणु उत्पन्न कर

सकता है लेकिन मादा 45-50 वर्ष की आयु तक ही अंडे उत्पन्न कर सकती है। इस आयु के बाद उसमें न तो अंडोत्सर्ग होता है और न ही रजोधर्म।

शरीर के अन्य अंगों की तरह जनन अंग भी महत्वपूर्ण हैं जिनकी स्वच्छता दूसरे अंगों की तरह करनी चाहिए। जनन अंगों के कार्य करने की प्रणाली को अनावश्यक गुप्त रखने से बहुत-सी गलत धारणाएं उत्पन्न हो गई हैं।

निषेचन को नियंत्रिण करना संभव है क्योंकि अण्डा निषेचन के लिए कुछ ही समय के लिए उपलब्ध रहता है। अब यांत्रिक, रासायनिक तथा शल्य युक्तियाँ उपलब्ध हैं जिनसे शुक्राणु तथा अंडे के मिलने को अथवा गर्भ को रोका जा सकता है। सभी जागरुक नागरिकों को अपने परिवार को नियोजित करने के लिए किसी भी विधि का उपयोग करना चाहिए। इससे जनसंख्या की वृद्धि रुक सकेगी और परिवार का कल्याण हो सकेगा।

19.4 नियंत्रण तथा समन्वय

जब आप भोजन कर रहे हों तब आप अपने शरीर की विभिन्न क्रियाओं के विषय में सोचिए। आपकी आंखें भोजन देखने में सहायता करती हैं, आपकी नाक भोजन की गंध सूंघने में सहायता करती है और आपके हाथ भोजन को मुख तक पहुंचाते हैं। मुख भोजन को ग्रहण करता है। दांत तथा जबड़े की पेशियां भोजन को चबाती हैं और लार पाचन की प्रक्रिया प्रारम्भ करती हैं। यदि इनमें से कोई भी क्रिया किसी चरण से अलग हो जाए तो कुछ कठिनाई हो सकती है। इसी प्रकार जब आप दौड़ रहे होते हैं तब आपकी सांस लेने की दर बढ़ जाती है और आपकी मांसपेशियों को अधिक ऑक्सीजन की आवश्यकता होती है, जब आप दौड़ना बन्द कर देते हैं तब आपकी सांस तथा हृदय गति सामान्य हो जाते हैं।

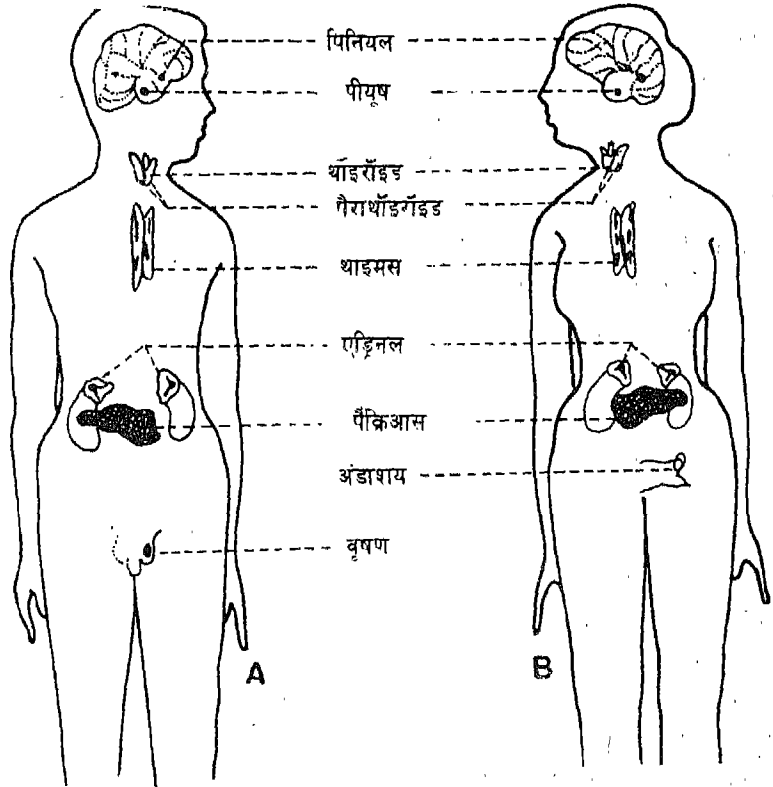
इन सभी क्रिया कलापों में शरीर के विभिन्न अंग मिलकर कार्य करते हैं। एक तंत्र का समन्वयन तथा कार्य अन्य तन्त्रों द्वारा समन्वित होता है। समन्वय के बिना हम कोई भी कार्य नहीं कर पाते जो हम एक जीव के रूप में करते हैं।

नियंत्रण तथा समन्वय जीव के भीतरी तथा बाहरी वातावरण का संतुलन बनाए रखने में सहायता करता है। उदाहरण के लिए हमें गर्मियों में अधिक पसीना आता है। पसीने के वाष्पित होने के बाद हमारा शरीर ठण्डा हो जाता है। चूंकि पसीनें से हमारे शरीर से पानी की बहुत हानि हो जाती है इसलिए इस कमी को पूरा करने के लिए हमें प्यास लगती है और हम अधिक पानी पीते हैं। पसीना आना तथा प्यास लगना शरीर की क्रिया के ही कारण है। इससे शरीर में पानी तथा ताप में एक इष्टतम् संतुलन बना रहता है। इसी प्रकार पहाड़ों की ऊँचाई पर चढ़ने वाले पर्वतारोही ऑक्सीजन की कमी अनुभव करते हैं। इससे उनके शरीर की क्रियात्मक क्रियाओं में परिवर्तन आता है और इस परिस्थिति का मुकाबला करने के लिए उनमें लाल रुधिर कोशिकाएं अधिक बन जाती हैं। उनका भीतरी वातावरण बाहरी परिवर्तनों को सहने का प्रयत्न करता है जिससे शरीर के कार्य सुचारू रूप से चलते रहते हैं। शरीर को स्वस्थ बनाये रखने में सहायक अवस्था को बनाये रखने की क्षमता को **होमियोस्टेसिस** कहते हैं। लेटिन में होमियो का अर्थ है समान तथा स्टेसिस का अवस्था अर्थात समान अवस्था। उच्च वर्गीय जीवों में शरीर की क्रियात्मक क्रियाओं को नियंत्रित करना भी उतना

ही आवश्यक है जितना समन्वय।

नियंत्रण तथा समन्वय केवल उन्हीं जीवों में महत्वपूर्ण है जिनमें अलग-अलग अंग अथवा शरीर क्रियात्मक तन्त्र होते हैं। अमीबा में इस प्रकार के कार्यों की आवश्यकता नहीं होती। इनकी कोशिकाओं में कोशिकांग होते हैं जो उनके कार्यों में आवश्यक समन्वय कर लेते हैं। बहुकोशिकीय जीवों में दो प्रकार का समन्वय देखा गया है—रासायनिक तथा तंत्रिका समन्वय। इस संदर्भ में पौधों तथा जन्तुओं में विभिन्नता है। पौधों में तंत्रिका तन्त्र नहीं होता जबकि हाइड्रा जैसे निम्नवर्गीय जीव में भी तंत्रिका तंत्र होता है। पौधों में समन्वय केवल रासायनिक विधि द्वारा होता है।

19.5 पौधों में रासायनिक समन्वय

पौधे अपनी कोशिका में कुछ विशेष रसायन उत्पन्न करते हैं जो पौधे की वृद्धि को नियमित करते हैं। इनमें से कुछ रसायन पौधे की वृद्धि को उत्प्रेरित करते हैं जबकि कुछ अन्य इसके

चित्र 19.7 पुरूष तथा स्त्री के शरीर में विभिन्न अंतः स्त्रावी ग्रन्थियों की स्थिति।

विपरीत कार्य करते हैं अर्थात् वृद्धि दर को कम कर देते हैं। इन रसायनों को पादप वृद्धि नियमक कहते हैं। इन्हें ऑक्सिन, साइटोकाइनिन अथवा पादप हॉर्मोन (हॉर्मोन शब्द ग्रीक भाषा का है जिस का अर्थ है गति में उत्प्रेरित करना या उत्तेजित करना) भी कहते हैं। विभिन्न रासायनिक नियामक हैं जो वृद्धि, गति तथा फूल खिलने को नियंत्रित करते हैं। ऑक्सिन प्रायः अंकुरित हुए बीजों की वृद्धि के अग्र भाग पर उत्पन्न होता है और प्ररोह को वृद्धि के लिए प्रोत्साहित करता है। लेकिन अंकुरित जड़ों में ऑक्सिन वृद्धि दर को कम कर देता है। आप देख सकते हैं कि एक ही पदार्थ किसी पौधे के एक स्थान पर तो वृद्धि करता है तथा दूसरे स्थान पर वृद्धि में रुकावट डालता है। ऑक्सिन अन्य शरीर क्रियात्मक क्रियाओं जैसे पत्तियों का गिरना, फूलों का खिलना तथा फलों का बनना एवं पकना आदि को भी प्रभावित करता है। पौधे को प्रभावित करने के लिए हॉर्मोन की बहुत ही कम मात्रा में आवश्यकता होती है। इस प्रकार हम देखते हैं कि हॉर्मोन एक स्विच की तरह कार्य करता है।

ऐसे नियामक के कुछ उदाहरण हैं जैसे जिबेरलिन तथा एब्सेसिक ऐसिड। जिबेरलिन वृद्धि चोटियों पर होता है और वह कोशिका विभाजन तथा उनका दीर्घीकरण करने के लिए उत्तेजित करता है। यह प्रायः बीजों की प्रसुप्त अवस्था को समाप्त करके उसे अंकुरित करता है और पौधों में फूल खिलाने की प्रक्रिया में सहायता करता है। ऐसा अनुमान है कि एब्सेसिक ऐसिड पौधों से पत्तियों, फूलों तथा फलों के गिरने को नियमित करता है।

19.6 जन्तुओं में रासायनिक समन्वय

पौधों की तरह जन्तुओं में भी शरीर की क्रियात्मक प्रक्रियाओं को नियमित करने के लिए विशेष रसायन होते हैं। ये हॉर्मोन जिन विशेष अंगों में उत्पन्न होते हैं उन्हें अन्तःस्रावी ग्रन्थि कहते हैं। इन ग्रन्थियों में कोई भी वाहिका नहीं होती (जैसा कि अंडाशय अथवा वृषण में) और वे हॉर्मोन को सीधे ही रुधिर प्रवाह में स्रावित करती हैं। शरीर के किन्हीं भागों में पहुंचकर ये हॉर्मोन विशेष परिवर्तन करते हैं जैसे शरीर की वृद्धि की दर, लैंगिक परिपक्वता आदि। चित्र 19.7 में शरीर में अन्तःस्रावी ग्रन्थियों की स्थिति देख सकते हैं। स्त्री तथा पुरुष में बहुत सी अन्तःस्रावी ग्रन्थियाँ समान होती हैं लेकिन उनके कार्यों में असमानता होती है। कुछ लैंगिक ग्रन्थियां भी होती हैं। पुरुष में वृषण होते हैं तो स्त्री में अंडाशय। तालिका 19.2 में विभिन्न ग्रन्थियों द्वारा स्रावित हॉर्मोन तथा शरीर में उनके कार्यों को आप देख सकते हैं।

आपने उपरोक्त तालिका में देखा है कि कभी कभी एक हॉर्मोन दूसरे हॉर्मोन के विपरीत कार्य करता है। TSH थॉयरॉक्सिन के उत्पादन को उत्तेजित करता है लेकिन यदि थॉयरॉक्सिन का उत्पादन अधिक हो तो पीयूष क्रिया करता है और वह TSH के उत्पादन को नियंत्रित करता है। इसके परिणामस्वरूप यह थॉयरॉक्सिन उत्पादन को ईष्टतम स्तर पर रखता है। इस प्रकार हम देखते हैं कि TSH तथा थॉयरॉक्सिन एक दूसरे के स्तर को नियंत्रित करते हैं। इस प्रकार की क्रिया आप साईकिल के पैडल तथा ब्रेक में भी देख सकते हैं। इस प्रकार के विपरीत

तालिका – 19.2

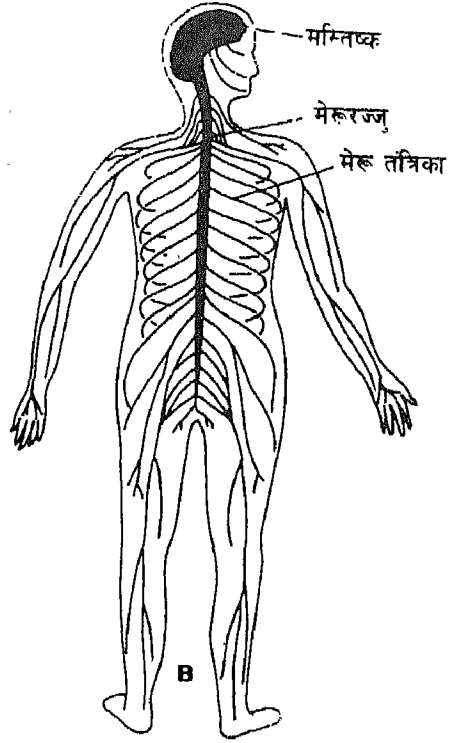
मनुष्य के शरीर में कुछ महत्वपूर्ण हार्मोन

ग्रन्थि	*हॉर्मोन*	*कार्य*
थॉइरॉइड	थॉयरॉक्सिन	उपापचय तथा वृद्धि की दर नियमित करता है। इस हार्मोन की कमी होने से मोटापा बढ़ता है और शरीर में शिथिलता आ जाती है। अधिकता से शरीर अति सक्रिय हो जाता है तथा भार गिर जाता है।
अग्नाशय	इन्सूलिन	शक्कर के उपापचय को नियमित करता है। इसकी कमी से रुधिर में शक्कर का स्तर बढ़ जाता है और कमजोरी आती है—ऐसी परिस्थिति को मधुमेह कहते हैं।
अधिवृक्क	कॉर्टिसोन	इस ग्रन्थि का बाहरी भाग कोर्टेक्स रस उत्पन्न करता है। यह प्रोटीन को शक्कर में बदलने में सहायता करता है। पीयूष ग्रन्थि कोर्टेक्स को उत्तेजित करती है।
पीयूष ग्रंथि (मास्टर ग्रंथि)	वृद्धि हार्मोन	हड्डी तथा ऊतकों की वृद्धि को नियमित करता है।
	ऐन्टीडाइयूरेटिक हार्मोन (ADR)	वृक्क द्वारा पुनः अवशोषित पानी की मात्रा को नियंत्रित करता है।
	ACTH	कॉर्टिसोन बनाने के लिए अधिवृक्क कोर्टेक्स को उत्तेजित करता है।
	FSH	एस्ट्रोजन बनाने के लिए अंडाशय को उत्तेजित करता है।
	TSH	थॉयरॉक्सिन बनाने के लिए थॉइरॉइड को उत्तेजित करता है।
अंडाशय	एस्ट्रोजन	बहुत से कार्य तथा गुण जैसे वक्ष का विकास करना।
वृषण	टेस्टोस्टरोन	पुरूष के बहुत से गुण जैसे मूंछ तथा दाढ़ी में वृद्धि करना।

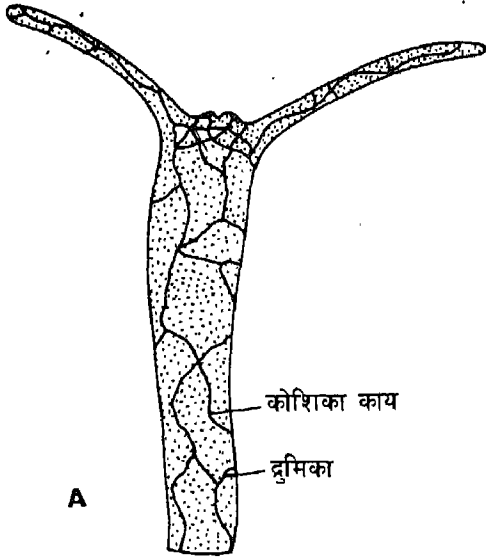
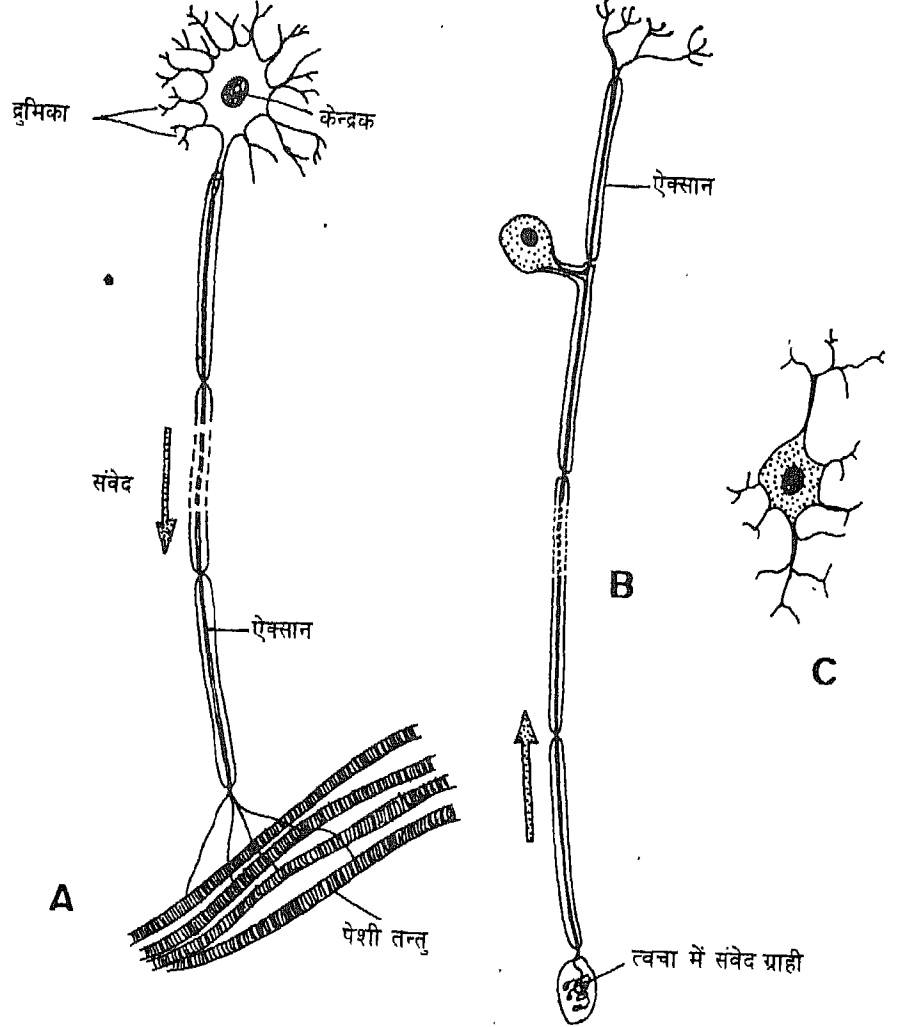
प्रभावों से तंत्र में नियंत्रण तथा संतुलन बना रहता है। दो विपरीत तंत्र परस्पर क्रियाएं करते हैं और सूचना का पुनर्निवेश करते हैं जिससे शरीर समायोजित हो सके। ऐसे पुनर्निवेश का प्रभाव ही होमियोस्टेसिस अथवा शरीर के कार्य में स्थिरता प्रदान करता है।

19.7 तंत्रिका तंत्र

अन्तःस्रावी ग्रन्थि तंत्र रुधिर प्रवाह द्वारा शरीर क्रिया को नियंत्रित करता है। नियंत्रण एवं समन्वय का अन्य तंत्र है —**तंत्रिका तंत्र**। इस तंत्र में सारे शरीर में ऊतकों की एक शृंखला सी रहती है। ये ऊतक विद्युत संवहन कोशिका का जाल सा बनाते हैं। तंत्रिकाओं द्वारा शरीर के एक भाग से संदेश दूसरे भाग में भेजे जाते हैं। चित्र 19.8

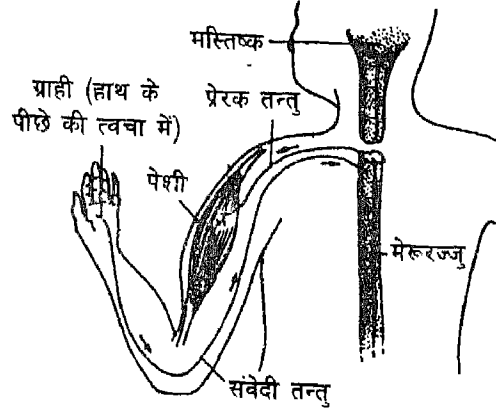
चित्र 19.8 (a) हाइड्रा का तंत्रिका तंत्र।

चित्र 19.8 (b) मनुष्य का तंत्रिका तंत्र।

में हाइड्रा तथा मनुष्य का तंत्रिका तंत्र दिखाया गया है। मनुष्य में तंत्रिका तंत्र बहुत जटिल है। उसमें एक विशेष भाग होता है जिसे **मस्तिष्क** कहते हैं। हाइड्रा में मस्तिष्क नहीं होता। इस भिन्नता के बावजूद भी दोनों में संदेश पहुंचाने की क्रिया मूलतः एक ही है। संदेश के संवाहन की मूल इकाई **तंत्रिकोशिका** है। यह तीन प्रकार की होती है — प्रेरक तंत्रिकोशिका, संवेदी तंत्रिकोशिका तथा बहुध्रुवी तंत्रिकोशिका।

सामान्य कोशिका से तंत्रिकोशिका बहुत भिन्न होती है। यह वास्तव में बिजली के तार की तरह दिखाई पड़ती है। एक सिरे पर यह

संवेदी ग्राही से जुड़ी रहती है। यह भाग संवेद को ग्रहण करता है और उसे विद्युत सिग्नल में बदल देता है। इस संकेत को तंत्रिकोशिका ले जाती है। तंत्रिकोशिका का दूसरा सिरा मस्तिष्क में जाता है जहां पर मस्तिष्क संदेश को ग्रहण कर उस पर क्रिया करता है। प्रेरक तंत्रिका संदेश को पेशी अथवा ग्रन्थियों से तंत्रिका केन्द्र तक ले जाती है। प्रायः संदेश को एक तंत्रिकोशिका से दूसरी तंत्रिकोशिका तक जाना पड़ता है। यह कार्य संगम स्थान द्वारा होता है

चित्र 19.9 तंत्रिका कोशिका। (a) प्रेरक तंत्रि कोशिका। (b) संवेदी तंत्रि कोशिका। (c) बहुध्रुवीय तंत्रि कोशिका।

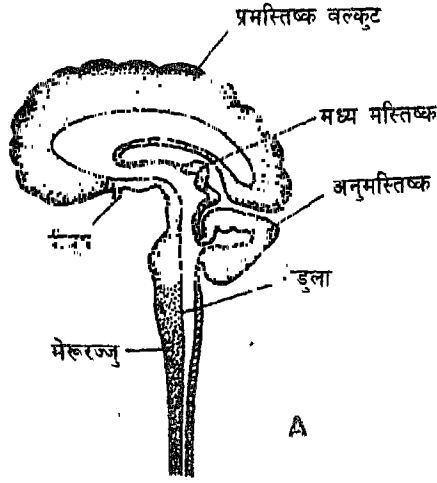
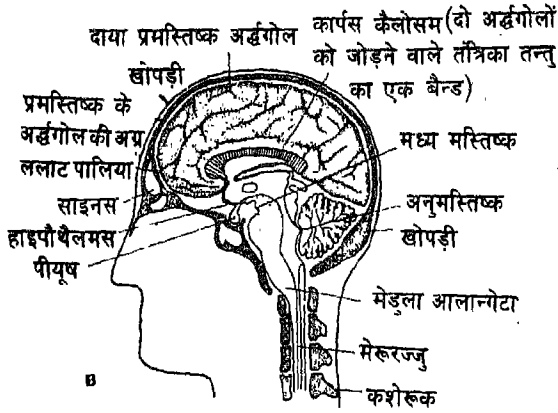
जिसे **अंतग्रथन** (सिनेप्स) कहते हैं। उदाहरणत: जब आपके पैर के अंगूठे में दर्द हो रहा हो तब इस संवेद को सबसे पहले आपकी तंत्रिकोशिका के डेन्ड्राइड अथवा बहुशाखीय रचनाएं ग्रहण करती हैं तथा तंत्रि कोशिकाओं के तंत्रि कक्ष द्वारा इसका उसी प्रकार परिवहन होता है जिस प्रकार विद्युत के तारों में विद्युत प्रवाह। इसकी अनुक्रिया का प्रेषण प्रेरक तंत्रिका द्वारा पैर की पेशियों तक हो जाता है। जिसके फलस्वरूप पैर की पेशियां उचित अनुक्रिया करती हैं।

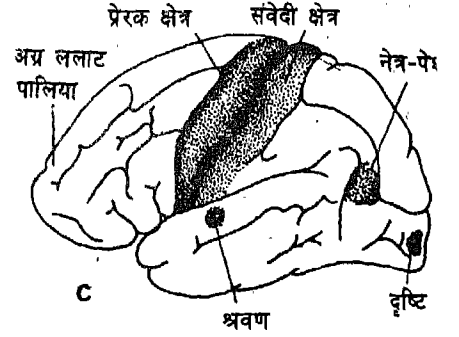
निम्नवर्गीय जन्तुओं जैसे हाइड्रा में एक ही तंत्रि-कोशिका संकेत को ग्रहण करके सारे शरीर में पहुंचाती है। लेकिन उच्च वर्गीय जीव जैसे मनुष्य में तंत्रिकोशिकाओं का एक बंडल (समूह) होता है जिसे तंत्रिका कहते हैं जो तंत्रिका केन्द्रों को विशेष अंगों से जोड़ती हैं। इन जीवों के केन्द्रीय तंत्रिका तंत्र में एक मस्तिष्क तथा मेरु रज्जु होता है (चित्र 19.8)। ये समन्वय केन्द्र संकेत को ग्रहण करके उचित कार्यवाही करते हैं। अनुक्रिया करने से पहले कुछ संकेतों का विश्लेषण करने की आवश्यकता होती है। उदाहरण के लिए प्रश्न का उत्तर देने में अथवा सामान्य सोच-विचार के लिए। इन उदाहरणों में मस्तिष्क संकेत का विश्लेषण करता है, संदेश पर कार्यवाही करता है तथा संचित संदेशों का उपयोग करता है और उसके बाद अनुक्रिया या उत्तर देता है। कुछ ऐसी भी अनुक्रियाएं हैं जो तुरन्त होती हैं और उसे मस्तिष्क में जाने की आवश्यकता नहीं होती। ऐसी अनुक्रियाओं को प्रतिवर्ती क्रियाएं कहते हैं। इसमें मेरुरज्जु ही अनुक्रिया करता है। आंखों का झपकना, छींक अथवा खांसी आना सभी प्रतिवर्ती क्रियाएं हैं जो कि किसी बाहरी अवांछनीय कणों के आँख, कान तथा गले में जाने से होती है। प्रतिवर्ती क्रिया का मार्ग निम्न है—

उद्दीपन→ ग्राही अंग→ संवेदी तंत्रिका→ मेरुरज्जु→ प्रेरक तंत्रिका→ पेशीय क्रिया

चित्र 19.10 प्रतिवर्ती क्रिया तथा उसका पथ।

चित्र 19.10 में प्रतिवर्ती लक्षणों का मार्ग दिखाया गया है कि यदि हाथ के पिछले भाग में पिन चुभ जाए तो किस प्रकार हाथ शीघ्र हट जाता है।

मस्तिष्क मेरुरज्जु का बढ़ा हुआ भाग है (चित्र 19.11 a)। इसके तीन स्पष्ट भाग होते हैं —**प्रमस्तिष्क वल्कुट** जो मस्तिष्क के ऊपरी आधे भाग में होता है। इसलिए इसे **अर्धगोला** कहते हैं। मस्तिष्क का यह भाग बहुत महत्वपूर्ण है क्योंकि यह चेतनशील होता है तथा सूचनाएं संचित करता है।

अनुमस्तिष्क, जो कि सिर के पीछे नीचे की ओर रहता है, यह सही-सही गतियों को नियंत्रित तथा समन्वित करता है। लम्बा भाग जो

चित्र 19.11 (a) मस्तिष्क मेरूरज्जु का बढ़ा हुआ भाग।

चित्र 19.11 (b) मस्तिष्क के विभिन्न भाग।

मेरुरज्जु से जुड़ा रहता है उसे **मेडुला आलान्गेटा** कहते हैं। यह हृदय की धड़कन, रुधिर

चित्र 19.11 (c) बाएं अर्द्धगोले में क्षेत्रों की स्थिति।

वाहिकाओं तथा श्वसन – अधिकांश प्रतिवर्ती क्रियाओं एवं अनैच्छिक गतियों का नियंत्रण करता है। चित्र 19.11b में मस्तिष्क के सभी भागों को दिखाने के लिए सिर की काट दिखाई गई है। मनुष्य के मस्तिष्क में सबसे महत्वपूर्ण भाग प्रमस्तिष्क है जिसे विस्तार से चित्र 19.11c में दिखाया गया है। प्रमस्तिष्क के विशेष भाग शरीर के विशेष भागों को नियंत्रित करते हैं जबकि गोलार्द्धों में सूचनाएं तथा अनुमान संचित रहती हैं। ये चेतना, प्रवीणता, सोच-विचार आदि के लिए उत्तरदायी है। जिन जन्तुओं में प्रमस्तिष्क गोलार्द्ध अधिक विकसित नहीं होता, वे अधिक बुद्धिमान नहीं होते तथा सहज व्यवहार द्वारा कार्य करते हैं।

सारांश में मस्तिष्क के विभिन्न कार्य हैं:–

(a) सभी संवेदी अंगों से संदेश ग्रहण करना।
(b) इन संकेतों (सिग्नलों) का उत्तर देने के लिए सूचनाओं को उचित कार्यवाही के लिए प्रेरक तंत्रिका द्वारा पेशियों तथा ग्रंथियों में भेजना।

(c) विभिन्न संवेदी अंगों से प्राप्त उद्दीपनों तथा शरीर की क्रियाओं का समन्वय करना।
(d) चेतना तथा ज्ञान को सूचना के रूप में संग्रह करना और पिछले अनुभवों के आधार पर व्यवहार में परिवर्तन करना। मस्तिष्क का यही वह कार्य है जो मस्तिष्क को सोच-विचार तथा चेतना का अंग बनाता है।

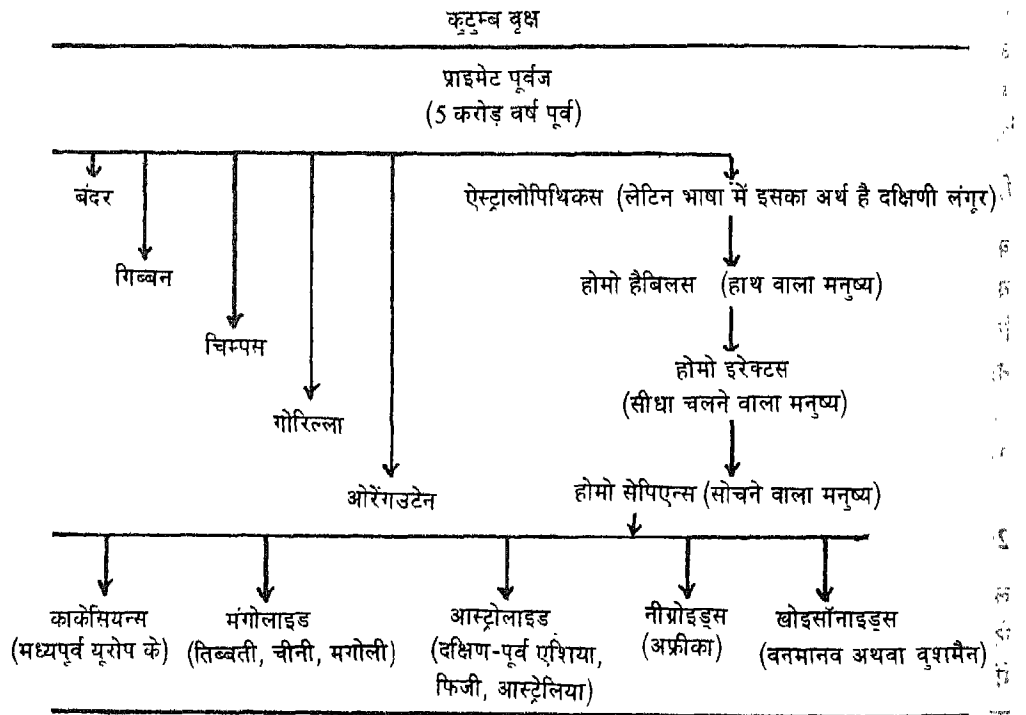
कल्पना करिये यदि हमारा प्रमस्तिष्क गोलार्द्ध पूर्ण रूप से विकसित न होता तो क्या होता।

प्रश्नावली

1. अलैंगिक जनन की विभिन्न विधियाँ कौन-कौन सी हैं?
2. कलम क्या है तथा स्कन्ध क्या है? वे दोनों रोपण में कैसे मिलती हैं?
3. पौधों में ऊतक संवर्धन क्या है?
4. उभयलिंगी क्या है? इसके दो उदाहरण दीजिए।
5. परागण से आरम्भ करके पौधे में बीज बनने तक सभी अवस्थाएं बताइये।
6. बाह्य निषेचन तथा भीतरी निषेचन का क्या अर्थ है? परिनिषेचन तथा स्वनिषेचन में क्या अंतर है?
7. होमियोस्टेसिस क्या है?
8. ऑक्सिन, जिबरेलिन तथा एब्सेसिक एसिड के क्या कार्य हैं?
9. हमारे शरीर में कुछ हॉर्मोनों द्वारा होने वाले पुनर्निवेश नियंत्रण का संक्षिप्त वर्णन करिए?
10. प्रतिवर्ती क्रिया जैसे छींक आना, में होने वाली घटनाओं का मार्ग बताइये।
11. मस्तिष्क के विभिन्न कार्य क्या हैं?
12. मस्तिष्क के विभिन्न भागों तथा उनके कार्यों का वर्णन करिये।

मानव

भूमिका

आपकी उत्पत्ति कैसे हुई? आपके माता पिता से। और उनकी उत्पत्ति? उनके माता पिता से। यदि हम इस तरह अपने पूर्व इतिहास का अवलोकन करें तो हम दृढ़ता से कह सकते हैं कि हमारे पूर्वज हैं। मनुष्य के वास्तविक पूर्वज (प्रथम मनुष्य) कहां से आये? इस पहेली का उत्तर हमें जीव विज्ञान से मिलता है। लगभग 100 वर्ष पहले इंग्लैंड के एक जीव वैज्ञानिक चार्ल्स डार्विन

चित्र 20.1 मनुष्य का कुटुम्बी चित्र।

ने कुछ अद्भुत सुझाव दिये। उन्होंने कहा कि मनुष्य, बन्दर और लंगूर के पूर्वज एक ही हैं। इन सौ वर्षों में डार्विन के विचारों की पुष्टि की जा चुकी है। मनुष्य की उत्पत्ति लंगूरों से हुई है जिन्हें हम **प्राइमेट्स** कहते हैं। प्राइमेट् पूर्वजों से बहुत सी शाखाएँ निकली। चित्र 20.1 में प्राइमेट्स के कुटुम्ब वृक्ष को दिखाया गया है। इस चित्र से स्पष्ट होता है कि मानव बन्दरों, गोरिल्लों और चिम्पांजी के सम्बन्धी हैं।

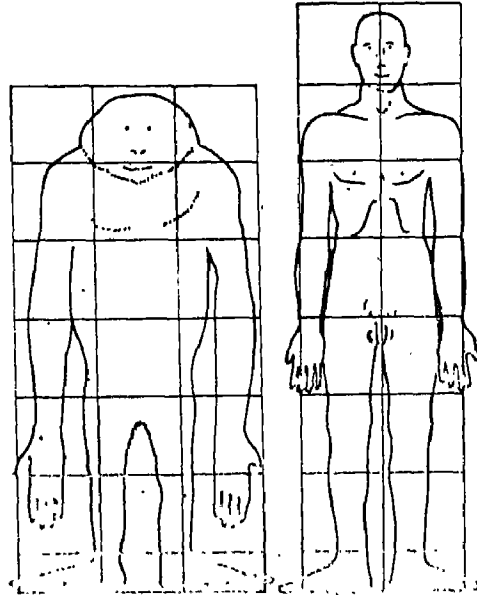
यह कुटुम्बी वृक्ष कैसे बनाया गया। यह वृक्ष धरती खोदने पर मिली हुई **हड्डियों**,कंकालों और दाँतों और ऐसे ही जीवाश्मों (fossil) के अध्ययन से बनाया गया है। उनकी आयु का सही-सही अनुमान लगाया गया और उनकी रचनाओं की मानव से तुलना की गई। इससे हमें उत्पत्ति का ज्ञान प्राप्त हुआ।

क्रियाकलाप — 1

क्या आप अपना कुटुम्बी वृक्ष बना सकते हैं? इस कुटुम्ब वृक्ष में आप अपने को सबसे नीचे दिखाइये ठीक उसी प्रकार जैसे चित्र 20.1 में नीग्रो अथवा कार्केसियन से आरम्भ किया गया है अपने भाइयों, बहनों, चाचा, चाचियों को भी शामिल करें।

20.1 मानव शरीर की रचना

लंगूर तथा गोरिल्ला हमारे समान हो सकते हैं लेकिन हमारी बनावट इनसे भिन्न है। चित्र 20.2 में लंगूर तथा मनुष्य में तुलना की गई है। उनमें कुछ अन्तर निम्नलिखित हैं:

1. लंगूर के हाथ उसके घुटनों से नीचे तक पहुंचते हैं जबकि मनुष्य के हाथ छोटे होते हैं। लंगूर चार टांगों पर चलता है और अपना संतुलन हाथ की अंगुलियों के जोड़ों पर बनाये रखता है परन्तु मनुष्य सीधा चलता है। इसलिए इसे **द्विपादी** कहते हैं। लंगूर के पैर किसी चीज को ऐसे पकड़ सकते हैं जैसे कि मनुष्य के हाथ। इस प्रकार लंगूर अपने चारों पैरों पर अपना संतुलन बनाता है। मनुष्य के पांव एक दृढ़ प्लेटफार्म की तरह काम करते हैं तथा संतुलन बनाये रखने में तथा सीधा चलने में सहायक होते हैं।
2. लंगूर का अंगूठा छोटा होता है जबकि मनुष्य का अंगूठा अधिक विकसित होता है। मनुष्य का अंगूठा हाथ की दूसरी

चित्र 20.2 मनुष्य तथा लंगूर के शारीरिक गुणों की तुलना।

अंगुलियों को दबा सकता है इससे वह अपने हाथ को बहुत से कामों के लिये चतुराई से उपयोग कर सकता है। मनुष्य के इस लाभ को कुशलता (dexterity) कहते हैं। वह लंगूरों की अपेक्षा छोटी छोटी वस्तुओं को भी अच्छी तरह से पकड़ सकता है तथा उनका प्रयोग कर सकता है।

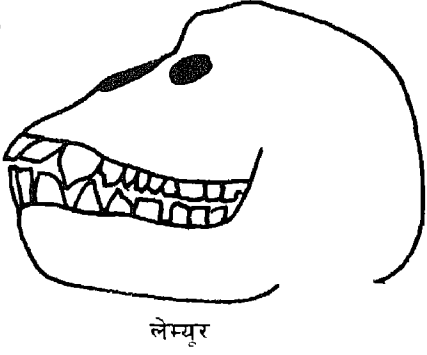
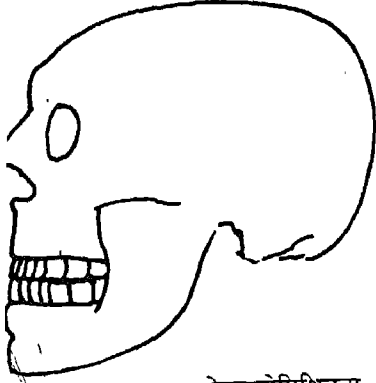
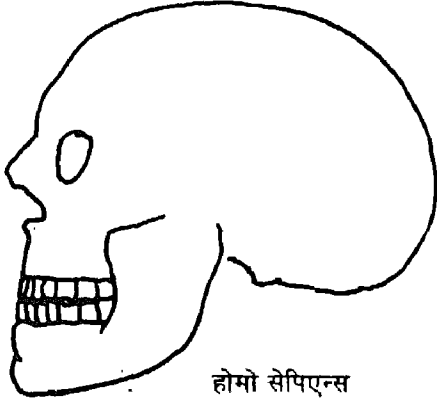
क्रियाकलाप – 2

अपने अंगूठे का उपयोग न करते हुए–
पेंसिल पकड़िये।
अपने मित्र से हाथ मिलाइये।
अपनी कमीज के बटन बंद कीजिए।
पानी से भरे हुए गिलास को एक हाथ से उठाइये।
आपको अपने अंगूठे का महत्व पता लग जाएगा।

3. चित्र 20.3 में लेम्यूर, **एस्ट्रालोपिथीकस** तथा **होमोसेपिएन्स** को दिखाया गया है। लेम्यूर छोटे बन्दर की तरह होता है और उसकी पूंछ लम्बी होती है। यह पेड़ों पर रहना पसन्द करता है तथा प्रायः रात को बाहर निकलता है। **होमोसेपिएन्स** एक लंगूर है जो भूमध्य रेखा के दक्षिण में पाया जाता है। **होमोसेपिएन्स** सोच विचार करने वाले मनुष्य हैं जैसे मैं और आप। लेम्यूर सबसे प्राचीन हैं। पृथ्वी पर इनकी उत्पत्ति 5 करोड़ वर्ष पूर्व हुई थी। दक्षिणी लंगूर की उत्पत्ति 2 करोड़ वर्ष पूर्व हुई थी जबकि मनुष्य की उत्पत्ति 2 लाख वर्ष पूर्व हुई। लेम्यूर की शरीरात्मक रचना बड़ी रुचिकर थी। नाक के नथुने छोटे थे। उसकी आंखें बड़ी थीं और दोनों के बीच में काफी दूरी थी। इसका अर्थ यह हुआ कि लेम्यूर नाक की अपेक्षा अपनी आंख का उपयोग अच्छी तरह कर सकता था। इसकी देखने की शक्ति सूंघने की शक्ति से अधिक थी (लेम्यूर में कोई पंजे नहीं होते थे लेकिन उसकी अंगुली पर नाखून होते थे। उसके एक छोटा सा अंगूठा भी होता था)।

   अब **एस्ट्रालोपिथीकस** के कपाल को देखो। इसके दांत हमारे दांतों की तरह हैं। इसके नथुने लेम्यूर की तरह नहीं है। यह एक नाक की तरह दिखाई देते हैं। चेहरे का उभार कुछ कम है। सबसे महत्वपूर्ण बात यह है कि इसके मस्तिष्क का साइज लेम्यूर के मस्तिष्क से बड़ा है। जब हम **होमोसेपिएन्स** को देखते हैं तो पता चलता है कि उसके दाँत छोटे हैं और क्रमबद्ध हैं। जबड़ा तथा नाक छोटी है, मस्तिष्क का साइज सबसे बड़ा है। मनुष्य, जबड़े अथवा नाक की अपेक्षा मस्तिष्क का अधिक उपयोग करना सीख गया है। मनुष्य के यह गुण अन्य जन्तुओं से बहुत भिन्न हैं।

4. मनुष्य के कपाल पर स्थित आंखों का अन्तर उसको साफ देखने में तथा दूरी का अनुमान लगाने में सहायता करता है।
5. मनुष्य में रंग देखने की क्षमता होती है। अन्य बहुत से जानवर रंग नहीं देख सकते इसका कारण यह है कि मनुष्य की आंखों में विशेष प्रकार की कोशिकाएं होती हैं जो रंगभेद के प्रति संवेदनशील होती हैं।
6. बहुत से जानवरों का जननकाल ऋतु के अनुसार होता है। आपको शायद पता होगा कि कुत्ते का जननकाल वर्ष के कुछ ही समय में होता है। लेकिन मनुष्य का जनन

चित्र 20.3 लेम्यूर, ऐस्ट्रालोपिथीकस तथा होमोसेपिएन्स की कपाल (खोपड़ी)।

काल सारा वर्ष चलता रहता है।

इस प्रकार हम देखते हैं कि मनुष्य को अन्य जानवरों की अपेक्षा अधिक लाभ प्राप्त हैं। ये लाभ मनुष्य में शनैः शनैः आये हैं अचानक नहीं। यह लेम्यर, लंगूर तथा मनष्य में तलना करने पर स्पष्ट हो जाता है। मनुष्यों को सबसे बड़ा लाभ यह है कि वह अपने मस्तिष्क का उपयोग कर सकता है। तालिका 20.1 में विभिन्न जानवरों के मस्तिष्क के साइज को दिखाया गया है। इस तालिका से उनके मस्तिष्क के भार तथा शरीर के भार के अनुपात में तुलना की जा सकती है। इस अनुपात से पता लगेगा कि किसी जानवर का मस्तिष्क उसके शरीर की अपेक्षा कितना अधिक विकसित होता है।

उपरोक्त तालिका से पता चलता है कि सभी जानवरों की अपेक्षा मनुष्य में मस्तिष्क तथा शरीर के भार का अनुपात सबसे अधिक होता है। इस अनुपात से जन्तुओं की बुद्धिमता का मोटे तौर पर अनुमान लगाया जा सकता है। किसी भी स्पीशीज में मस्तिष्क का एक भाग शरीर के कार्यों का समन्वय तथा नियंत्रण करता है। ऐसा चूहे जैसे छोटे जानवर में भी होता है। इसी कारण चूहे में यह अनुपात अनुमान से अधिक है लेकिन हमें भेड़िये, चिम्पांजी तथा मनुष्य की भी तुलना करनी चाहिए। इन सभी के शरीर का भार लगभग बराबर है, फिर भी मनुष्य में मस्तिष्क तथा शरीर के भार का अनुपात सबसे अधिक है। इसीलिए मनुष्य में सबसे अधिक विकसित मस्तिष्क होना चाहिए। इसी विकसित मस्तिष्क के कारण मनुष्य सोचता है, अपने विचारों को एकत्र करता है और निर्णय लेता है। मनुष्य में कल्पना करने की शक्ति

अधिक होती है इसीलिए मनुष्य को सोच विचार वाला जानवर (Thinking animal) कहते हैं।

मनुष्य के मस्तिष्क का विकास अन्य संवेदी अंगों की कीमत पर हुआ है। उदाहरण के लिए, उत्पत्ति के दौरान मनुष्य की घ्राण शक्ति कम हो गई जबकि कुत्ते में बहुत अधिक होती है। मनुष्य के कान चमगादड़ की अपेक्षा केवल लघु तरंगों वाली आवाज को सुन सकते हैं। मनुष्य घास, भूसा आदि न तो खा सकता है और न ही इसे पचा सकता है जबकि गाय यह सब कुछ कर सकती है। क्या आप ऐसे कार्यों की कोई सूची बना सकते हो जिन्हें मनुष्य नहीं कर सकता जबकि अन्य जानवर कर सकते हैं?

तालिका 20.1

कुछ जानवरों के शरीर तथा मस्तिष्क का भार

स्पीशीज	*शरीर का भार*	*मस्तिष्क का भार*	*मस्तिष्क/शरीर का अनुपात*
चूहा	200 g	2.5 g	1 : 80
भेड़िया	80 kg	150 kg	1 : 530
चिम्पांजी	80 kg	300 g	1 : 265
मनुष्य	70 kg	1.5 kg	1 : 46

20.2 मनुष्य वातावरण का समुपयोजन (exploitation) करता है

आदि मानव: हमने मानव में पाई जाने वाली विभिन्न कमियों की एक सूची बना ली है। फिर भी मनुष्य को जीवित रहना है और फलना फूलना है। इस प्रक्रिया में मनुष्य ने अपने उपयोग के लिए वातावरण की उन वस्तुओं का समुपयोजन किया है जो उसके लिए लाभकारी हैं। 50,000 वर्ष पूर्व तक मनुष्य भी अन्य स्तनधारियों की तरह ही "जंगली" था। यहां "जंगली" शब्द से तात्पर्य है कि मनुष्य कभी भी एक स्थान पर नहीं रहा और न ही उसने सामुदायिक जीवन व्यतीत किया। बल्कि मनुष्य झुंड बनाकर एक स्थान से दूसरे स्थान तक घूमते रहते थे। घूमने का मुख्य उद्देश्य आश्रय तथा भोजन की तलाश तथा भक्षकों तथा अन्य खतरों से अपनी रक्षा करना था। मनुष्य के विकसित मस्तिष्क के कारण उसके कार्य करने की क्षमता में बढ़ोतरी हुई।

सबसे प्रचीन महत्वपूर्ण बात थी औजारों का बनाना। इस काम के लिए सोचने (मस्तिष्क से सोचने) तथा हाथ से काम करने की आवश्यकता होती है। हम जानते हैं कि लंगूर बहुत ही निम्न स्तर का औजार बना सकता है। लेकिन औजार बनाने की तकनीक में उन्नतिएस्ट्रालोपिथीकसके समय में हुई। इसी काल में खाने की आदतों में भी परिवर्तन हुए। पहले वाले लंगूर शाकाहारी थे

लेकिन **एस्ट्रालोपिथीकस** मांसाहारी थे। खाने की आदत के इस परिवर्तन का अर्थ था सुव्यवस्थित ढंग से शिकार करना। इस क्रियाकलाप को करने के लिए सामाजिक जीवन तथा संचार माध्यम का विकास करना आवश्यक था। विशेष हथियारों द्वारा योजना बनाना तथा संगठित होना बहुत आवश्यक था।

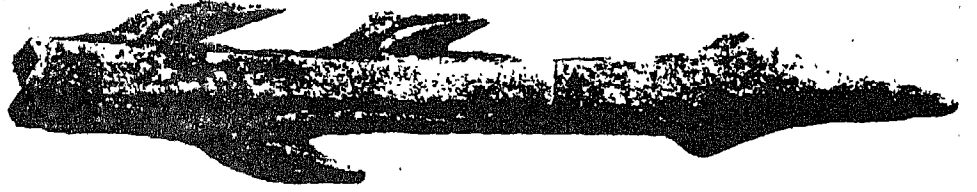
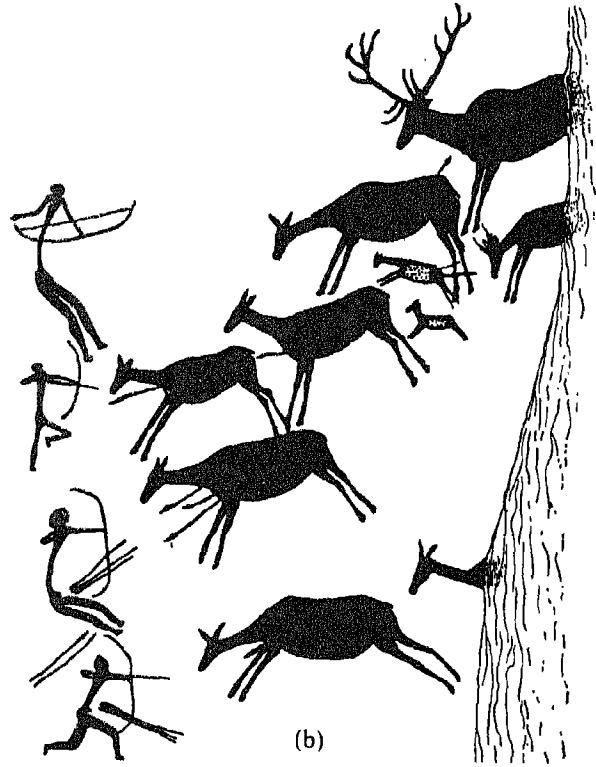
भाषा द्वारा संचार करने में मस्तिष्क का बहुत बड़ा योगदान है। मनुष्य का मस्तिष्क सब जानवरों के मस्तिष्कों से अधिक विकसित है। इसलिए यह स्वाभाविक ही है कि मौखिक संचार प्रणाली सबसे पहले मनुष्य में ही विकसित होनी आरम्भ हुई।

शिकार पर आधारित जीवन निर्वाह एक ही स्थान पर नहीं हो सकता था। मनष्य जिसने अब समूह में रहना शुरू कर दिया था को भोजन की तलाश में घूमना पड़ता था। वास्तव में यह प्रवासी जीवन 10 लाख वर्ष पूर्व आरम्भ हो गया था। मनुष्य सवाना (Savannah) से उत्तरी अफ्रीका, चीन, इण्डोनेशिया तथा उत्तरी यूरोप की ओर चले गए थे। लगभग इसी काल में मनुष्य ने न केवल आग की खोज की, बल्कि उसने आवश्यकता पड़ने पर आग जलाना भी सीख लिया था। आग जलाने की विद्या मनुष्य के इतिहास में एक और महत्वपूर्ण घटना है। आग द्वारा मनुष्य मौसम तथा जंगली जानवरों से अपनी रक्षा करते थे तथा ये खाना पकाने का साधन भी थी।

शिकार के लिए विशेष प्रकार के हथियारों की आवश्यकता पड़ती थी। इसके लिए मनुष्य ने कुल्हाड़ी तथा पहिए का विकास किया। वे कुल्हाड़ी से जानवरों के मांस के छोटे छोटे टुकड़े करते थे और पहियों की सहायता से उसे एक स्थान से दूसरे स्थान तक आसानी से पहुंचा देते थे। वास्तव में पहिए की खोज मनुष्य की उन्नति में बहुत ही महत्वपूर्ण है।

मनुष्य की पूर्व तकनीकी मुख्यतः आग, औजार, संवहन तथा भाषा थी। इन सभी तकनीकियों से मनुष्य भोजन, आश्रय, कपड़ा तथा सुरक्षा प्राप्त कर सका। प्राचीन काल में मनुष्य गुफाओं में रहता था, जानवरों की खाल और पेड़ों की छाल से शरीर ढकता था और समूह बनाकर रहता था। आदि मानव ने न केवल इस आदिम तकनीकी का उपयोग ही किया बल्कि इसका आभारी भी रहा है। इससे इसे आराम के लिए तथा जीवन के अन्य मामलों के बारे में विचार करने के लिए समय मिला। यह कई स्थानों से प्राप्त चित्रकारी से भी सिद्ध होता है। इनमें से कुछ भारत में मध्य प्रदेश के जबलपुर के समीप स्थित पचमढ़ी की गुफाओं में है। चित्र 20.4a में हारपून नामक हथियार के जीवाश्म (फॉसिल) दिखाए गए हैं। ये हथियार रेंडियर के सींगों से बनाए गए थे। हारपून पर कांटों की दो कतारों को देखिए। ऐसा लगता है कि हारपून पर कांटों की दो कतारें लगभग 20,000 वर्ष पूर्व में ही बनाई गई थी। चित्र 20.4b में 10,000 वर्ष पूर्व की एक गुफा की चित्रकारी दिखाई गई है। तीर कमानों की खोज भी हो गई थी। मनुष्यों के झुंड के झुंड मिलकर शक्तिशाली जानवर को भी मार देते थे। लगभग इसी काल में मनष्य ने जानवरों को पालतू बनाना भी आरम्भ कर दिया था, उदाहरण के लिए कुत्ता, गाय, भैंस, भेड़, बकरी, हिरण, घोड़ा आदि।

कृषि तथा जीवन के रहन-सहन में परिवर्तन

तकनीकी आविष्कार से मनुष्य अपने उपयोग के

(a)

(b)

चित्र 20.4 (a) कांटों की दो कतारों वाला हारपून। (b) रेंडियर के शिकार की चट्टान पर पेंटिंग। यह पूर्वी स्पेन की गुफा से है। देखो तीर कमान के उपयोग की खोज। यह भी देखो कि अब तक शिकार झुंड के रूप में करने की प्रथा हो गई थी। (a) तथा (b) दोनों ही 30,000 वर्ष पुराने हैं।

लिए पर्यावरण का दोहन (समुपयोजन) करने में सक्षम हो गया था। इस विकास से उसके जीवन में सांस्कृतिक अनुकूलन हुआ। यायावर आखेटी जीवन का अंत हुआ तथा मानव एक स्थान पर टिक कर रहने लगा था। शिकार करने का मुख्य उद्देश्य केवल भोजन प्राप्त करना ही नहीं था। जन्तुओं की खाल से तंबू बनाए जाते थे। उनके खुरों तथा फरों से कपड़े तथा अन्य वस्तुएं बनाई जाती थीं, सींगों से हथियार तथा अन्य औजार बनाए जाते थे। पालतू जानवरों का उपयोग घरेलू कामों तथा सामान ढोने में किया जाने लगा।

चावल तथा गेहूं का उपयोग मुख्य भोजन के रूप में होने लगा। लेकिन सब चीजें जंगली पौधों से प्राप्त होती थी। ईसा से लगभग 8000 वर्ष पूर्व गेहूं की नई किस्म उत्पन्न हुई जिसका बीज भूसे से चिपका रहता था। हाथ से छिलके को हटाकर इसके बीजों को उगाना पड़ता था। गेहूं की इस नई किस्म को संचित कर सकते थे और उसे किसी भी स्थान पर आवश्यकतानुसार उगा सकते थे। इस खोज के साथ संगठित रूप से खेती-बाड़ी का आरम्भ हुआ और इस तरह कृषि का आरम्भ हुआ। जब कृषि व्यावहारिक रूप में आई तब फिर मनुष्य के सामूहिक जीवन में परिवर्तन आया। छोटे-छोटे समूहों के स्थान पर बड़े-बड़े समुदाय बने, नहरें बनाई गईं, अनाजों का संग्रह करना आरम्भ हुआ और मनुष्य पशुचारणिक बन गया। वास्तव में कृषि ने मनुष्यों को समुदायों, कस्बों, प्रांतों तथा राष्ट्र में संगठित किया। इसके बाद मनुष्य ने पर्यावरण का अधिक समुपयोजन करना शुरू कर दिया।

कृषि में काम आने वाले औजार विशेष प्रकार के थे। उनके आकार, साइज और कठोरता आदि भी भिन्न थी और वे विभिन्न प्रकार के थे। मिट्टी को पलटने, खेत में हल चलाने, निशान लगाने, बीज बोने, फसल काटने, फटकारने तथा संग्रह करने के लिए विभिन्न प्रकार के औजारों की आवश्यकता होती थी। इन सब के लिए नई उपयुक्त वस्तुओं अथवा सामग्रियों की खोज आवश्यक हो गई। इस प्रकार हम देखते हैं कि मनुष्य को तकनीकी उन्नति की रफ्तार पाषाण काल, कांस्य काल, लोह काल आदि में अधिक है। यायावर या खानाबदोशी जीवन से ग्रामीण जीवन के परिवर्तन में लगभग दस लाख वर्ष लग गये। लेकिन आदिम कृषि से मोहनजोदाड़ों अथवा हड़प्पा अथवा लोथल संस्कृति तक पहुंचने में कुछ हजार वर्ष ही लगे। घरेलूकरण तथा सामुदायिक जीवन से मनुष्य ने काफी कुछ सीखा और नये नये आविष्कार हुए।

क्रियाकलाप – 4

भारत में ऐसे संग्रहालय कहाँ हैं जिनमें भारत की पुरातन वस्तुएं दिखाई गई हैं? अपने घर, विद्यालय अथवा कस्बे के पास यदि कोई संग्रहालय स्थित हो तो वहां जाइए। आपको वहां जाने पर रुचिकर अनुभव प्राप्त होगा।

अगला महत्वपूर्ण कदम था भवन निर्माण। भवन निर्माण की सामग्री थी पत्थर तथा उनको जोड़ने के लिए चूने का उपयोग होता था। ईसा से 2500 वर्ष पूर्व बने पत्थरों के भवनों, कुओं, तालाबों आदि के खण्डहर लेबनान, सीरिया तथा भारत उपमहाद्वीप में मोहनजोदाड़ों, हड़प्पा तथा लोथल में देखे जा सकते हैं।

तालिका 20.2 में मनुष्य की उत्पत्ति से लेकर

पूर्व सांस्कृतिक तकनीकी विकास को दिखाया गया है। आप देखेंगे कि शुरु-शुरू में तकनीकी विकास में बहुत अधिक समय लगा है। लेकिन प्लीस्टोसीन काल के आने के बाद इसकी विकास दर बहुत तेजी से बढ़ी थी। विकास दर मध्यपाषाणी युग से एशिया माईनर तक और भी तीव्र थी। यह भी देखिए कि मनुष्य को तकनीकी खोज करने तथा उसे व्यावहारिक बनाने में लाखों वर्ष लग गए। उसके बाद तकनीकी में उन्नति बड़ी तेजी से हुई। मनुष्य का सांस्कृतिक अनुकूलन जैविक अनुकूलन की अपेक्षा अधिक शीघ्र हुआ। अगले अध्याय में आप देखेंगे कि मनुष्य ने केवल 500 वर्ष में ही कितनी तेजी से पर्यावरण का समुपयोजन किया है। अब हम अन्तरिक्ष में जा सकते हैं। तारामंडल तथा समुद्र तल से सूचनाएं प्राप्त कर सकते हैं और परमाणु नाभिक से ऊर्जा (शक्ति) प्राप्त कर सकते हैं।

मनुष्य ने होमोइरेक्टस काल के बाद से अब तक बहुत उन्नति की है।

शिक्षा

विकसित मस्तिष्क होने के कारण मनुष्य को बहुत लाभ हुआ है। कीट जैसे चीटीं अथवा दीमक बहुत बड़े मिट्टी के बिल बना लेते हैं। बया पक्षी पौधे की पत्तियों, तिनकों आदि से बहुत सुंदर घोंसला बनाते हैं। इसी प्रकार अन्य जीवों के उदाहरण भी दे सकते हैं जिन्होंने पर्यावरण का समुपयोजन किया है। लेकिन ये सभी क्रिया-कलाप वंशागत अथवा आनुवंशिक हैं। केवल मनुष्य जो विचारशील जीव है ने ही सोच समझ कर पर्यावरण का समुपयोजन किया है। मनुष्य में यह विचार कभी भी क्रोमोसोम अथवा जीन द्वारा एक पीढ़ी से दूसरी पीढ़ी में नहीं जाते हैं। उनका संचार होता है और मस्तिष्क उन्हें ग्रहण करता है। पर्यावरण का समुपयोजन मनुष्य ने बड़ी बुद्धिमता से किया है। वह किसी विषय पर विचार करता है उसकी समस्याओं का विश्लेषण करता है और उनका समाधान ढूंढता है। इस क्रिया के कुछ उदाहरण हैं पहिया, आग, हथकरघा, धातु, औजार, घुड़सवारी, नौका तथा समुद्री जहाज।

जब विचार अधिक हुआ तब पर्यावरण का समुपयोजन भी अधिक हुआ। आजकल यह सूक्ष्म स्तर पर न होकर बड़े पैमाने पर हो गया है। आबादी बढ़ने के साथ-साथ पर्यावरण का समुपयोजन सारे संसार में हो रहा है। एक दृष्टि से देखा जाए तो यह लाभदायक हो सकता है। उदाहरणतः किसी वातावरण में उचित तकनीकी का उपयोग करके मनुष्य जीवित रह सकता है और किसी भी स्थान जैसे मरुस्थल अथवा टापु पर शहर बसा सकता है। अथवा भारत में बनी बीमारी की किसी दवा को संसार में कहीं पर भी भेजा जा सकता है। यदि इसको दूसरी दृष्टि से देखा जाए तो बहुत बड़े पैमाने पर प्राकृतिक संसाधनों का समुपयोजन हानिकारक भी हो सकता है। इसका एक उदाहरण है पहाड़ों में जंगलों का काटना। 50 वर्ष पहले हिमाचल प्रदेश के पहाड़ों, उत्तरी बंगाल अथवा उत्तर पूर्वी भारत में वृक्षों का काटना अधिक नहीं था लेकिन आजकल इन क्षेत्रों में वृक्ष बहुत अधिक संख्या में काटे गए हैं। याद रखिए वृक्ष को पूर्ण विकसित होने में कई वर्ष लग जाते हैं लेकिन काटने में एक दिन से भी कम समय लगता है। ये वृक्ष पहाड़ों पर उचित जलवायु, मिट्टी की संरचना तथा पारिस्थितिक स्थिरता बनाए रखते हैं। इन जंगलों के नष्ट होने से मिट्टी

तालिका 20.2

मनुष्य का शिल्प विज्ञान (तकनीकी)—ईसा से 3000 वर्ष पूर्व तक

युग	*समय*	*मनुष्य*	*तकनीकी विकास*
पूर्व पाषाण काल	1,00,000 वर्ष से भी पूर्व	होमोइरेक्टस जावा मानव, पीकिंग मानव	औजार बनाने में पत्थर का उपयोग। कुल्हाड़ी बनाने में हड्डी का उपयोग। खाना पकाना आरंभ हुआ।
गुफाओं में रहना	50,000 वर्ष से 100,000 वर्ष पूर्व	निअन्डर थल मनुष्य रोडेशियन मानव	मुर्दों को दफनाना, खाना पकाने में निपुणता, कला का उदय
हिम काल का अन्त	30,000 वर्ष पूर्व	प्लीस्टोसीन मानव	चाकू का फल, खोदने वाले औजार, कांटेदार हारपून, कला की वस्तुएं, जैसे नैकलेस, आभूषण आदि। जादुई कला तथा रीति रिवाज।
मध्य पाषाण काल	10,000 वर्ष से 8,000 ईसा वर्ष पूर्व	मीसोलिथिक मानव	मछलियां पकड़ने की विधियां, जंगली गेहूं तथा जौ, बकरी और भेड़ का जनन, कुत्तों को पालना, कृषि का आरम्भ होना।
नव पाषाण काल	6000-4000 ईसा वर्ष पूर्व	निओलिथिक मानव	कृषि, चीनी मिट्टी का सामान बनाना, कपड़ा, हथकरघे का विकास।
ताम्र काल	4000-3000 ईसा वर्ष पूर्व	सिंधु घाटी, सुमेरियन तथा इंजिप्सीयन सभ्यता	सीसा, जस्ता, टिन तथा एन्टीमनी की खोज। कांसा तथा अन्य मिश्र धातुएँ, पहिए वाली गाड़ी, समुद्री जहाज, बहुमूल्य पत्थर, ताँबे के मिश्र धातुओं का उपयोग।

का अपरदन हो गया, वर्षा कम हो गई तथा जलवायु में परिवर्तन आ गया। नदियों ने अपना रास्ता बदल लिया और प्रायः बाढ़ आने लगी। पहाड़ टूट कर गिरने की दर बढ़ गई। चूंकि वर्षा कम हो गई इसलिए उत्तर प्रदेश तथा बिहार में सूखा पड़ने लगा।

आपने सुना होगा कि संसार में सबसे अधिक वर्षा मेघालय में स्थित चेरापूंजी नामक स्थान पर होती थी। दुर्भाग्यवश अब ऐसा नहीं है। मेघालय की पहाड़ियों पर अंधाधुंध वृक्षों की कटाई में वर्षा होने तथा जलवायु में परिवर्तन आया है। पर्यावरण की ऐसी हानि मनुष्य ने ही की है। संतुलन बनाए रखने के लिए सबसे अच्छी विधि है वहां पर वृक्षों का लगाना। आजकल वहां के निवासी तथा सरकार इस कार्य में लगे हुए हैं। प्रायः ऐसी हानि अपरिवर्तनीय भी बन सकती है। यह बड़े दुःख की बात है कि ऐसी हानि का जिम्मेवार मनुष्य है, जो कि एक विचारशील जन्तु है।

यह सर्वविदित है कि मनुष्य को अपने आराम तथा सुख सुविधा के लिए अपने आस-पास के पर्यावरण में स्थित संसाधनों का उपयोग करना पड़ता है। ऐसा करना अल्पबुद्धिमता होगी कि हम साधारण आदिवासी वाला जीवन व्यतीत करना शुरू कर दें। पहले के जीवन की बहुत सी कठिनाइयों ने ही बिजली, गाड़ियों, हवाई जहाज, टेलीफोन तथा कम्प्यूटर जैसे आविष्कारों का मार्ग प्रशस्त किया। महत्वपूर्ण बात यह है कि हम नई तकनीकों को अपनाने से पहले यह पता लगा लें कि इनका पर्यावरण पर क्या बुरा प्रभाव पड़ सकता है। यह कार्य इतना आसान नहीं है। दाढ़ी बनाने वाले साबुन व क्रीम का उदाहरण ले सकते हैं। भारत में प्रायः सामान्य विधि यह है कि दाढ़ी बनाने में झाग बनाने के लिए हम साबुन की टिक्की अथवा शेविंग क्रीम तथा ब्रुश का उपयोग करते हैं। यूरोप तथा अमेरिका में दाढ़ी बनाने वाला तैयार झाग डिब्बे में बन्द मिलता है। डिब्बे में साबुन से झाग पैदा करने के लिए कोई रसायन जिसे "ऐरोसॉल" कहते हैं मिलाया जाता है। जब आप डिब्बे को ऊपर से दबाते हो तब झाग बाहर निकलता है। इस झाग को ब्रुश की सहायता के बिना मुंह पर लगाया जा सकता है। "ऐरोसॉल" का उपयोग न केवल साबुन में ही होता है बल्कि अन्य पदार्थों में भी होता है। लेकिन अभी हाल ही में पता चला है कि ऐरोसॉल हमारी पृथ्वी को प्रदूषित करता है। ये वायु मण्डल में स्थित ओजोन से अभिक्रिया कर उसे नष्ट कर देते हैं। ओजोन हमारी पृथ्वी का कवच है जो सूर्य से आने वाली हानिकारक पराबैंगनी किरणों को पृथ्वी पर आने से रोकता है। इस प्रकार ओजोन की कमी होने से पृथ्वी पर स्थित जीवों का जीवन खतरे में पड़ सकता है। जब "ऐरोसॉल" के हानिकारक प्रभाव का पता लगा तो उन देशों में इसके उपयोग पर प्रतिबन्ध लगाने का प्रयास प्रारम्भ हुआ। बहुत से देशों में तो इस रसायन के उपयोग पर प्रतिबन्ध लगा दिया गया है। बहुत से वैज्ञानिक सुरक्षित ऐरोसॉल बनाने का प्रयत्न कर रहे हैं।

दूसरा उदाहरण है कीटनाशक तथा पीड़कनाशी (Pesticide) रसायन। ये रसायन फसलों को नष्ट करने वाले कीटों तथा पीड़ (Pest) को मार देते हैं। सारे संसार में इनके उपयोग से कृषि की पैदावार बढ़ी है। लेकिन अब कीटों की ऐसी नई किस्में उत्पन्न होती जा रही हैं जिन पर ये रसायन प्रभावकारी नहीं हैं। ये ऐसे रसायन नहीं है

जो प्राकृतिक रूप में मिलें। मिट्टी में पाए जाने वाले साधारण जीवाणु इनका अपघटन नहीं करते। और मनुष्य जब कीटनाशियों द्वारा प्रदूषित भोजन खाता है तो वह बीमार हो जाता है। कीटनाशियों के उपयोग से कीटों को मारकर उपज तो बढ़ा ली है लेकिन मनुष्य के स्वास्थ्य पर उनका बुरा प्रभाव पड़ा है। इससे हमने एक सबक तो सीख लिया है। अब प्रश्न यह है कि हम अधिक से अधिक लाभ कैसे प्राप्त करें और इसके दुष्प्रभावों को कैसे कम करें? अब ऐसे रसायनों को बनाने के प्रयत्न किये जा रहे हैं जो कीटों को तो नष्ट कर दें, लेकिन अन्य जीवों को कोई नुकसान न पहुंचाए। ऐसे रसायन भी बनाए जा रहे हैं जिनका जैव अपघटन हो सके अर्थात् मिट्टी में स्थित जीवाणु उनको अपघटित करने में सक्षम हो।

किसी भी तकनीकी के उपयोग से लाभ तथा हानि दोनों होते हैं। सबसे अच्छी विधि तो वह है जिससे लाभकारी प्रभाव बढ़ें और हानिकारक प्रभाव कम हों। लेकिन ऐसा करना आसान नहीं है विशेष कर ऐसी परिस्थिति में जब इन रसायनों को बनाने के लिए धन अधिक लगा हुआ हो और अधिक लाभ कमाने की इच्छा हो। अब मुख्य झगड़ा है जल्दी लाभ कमाने तथा लम्बे समय तक पर्यावरण की सुरक्षा के बीच। सबसे अधिक हानि तभी होती है जब हमें जल्दी लाभ कमाने की इच्छा होती है। इस प्रकार पर्यावरण की रक्षा करने वाले संगठनों की एक महत्वपूर्ण भूमिका है। यह संगठन पर्यावरण की काफी समय तक रक्षा हो सके ऐसे विचारों को अपनाते हैं। ये प्रत्येक तकनीकी के प्रभाव का विश्लेषण करते हैं और उसकी दूसरी विधि बताते हैं। भारत में लोगों की जागृति का बहुत ही क्रियाशील तथा सफल उदाहरण उत्तर प्रदेश के टिहरी क्षेत्र में रहने वाले ग्रामीण तथा केरल और अन्य प्रान्तों की नागरिक संस्थाएं हैं। टिहरी के ग्रामीणों ने अपना आन्दोलन चिपको के रूप में चलाया, उन्होंने उत्तर प्रदेश के हिमालय क्षेत्र के वनों के पेड़ों को कटने से बचाया और साथ ही साथ नये वृक्ष भी लगाए। केरल की संस्थाओं ने साइलैंट वैली क्षेत्र के प्राकृतिक संग्रह को नष्ट होने से बचाने के लिए प्रयत्न किया, और इसे भारत के भविष्य के लिए संरक्षित रखने में सहायता की।

प्रश्नावली

1. लंगूर से मनुष्य तक विकास में पूंछ के ह्रास का क्या योगदान है?
2. भेड़ तथा रीछ पर अधिक ऊन अथवा बाल क्यों होते हैं?
3. मनुष्य द्वारा ईसा से 5000 वर्ष पूर्व उपयोग किए गए 10 औजारों के नाम लिखिए। ये औजार किस पदार्थ से बनाए गए थे?
4. तकनीकी विकास (कांस्य काल से लेकर कम्प्यूटर तथा उपग्रह तक) तथा समय (ईसा से 4000 वर्ष पूर्व से लेकर सन् 2000 तक) के बीच एक ग्राफ बनाओ।

5. सारांश में लिखिए कि किस प्रकार कृषि लोगों को संगठित करने में एक तकनीकी समझी जाती है।
6. किसी भी तकनीकी के लाभ तथा हानि दोनों ही होते हैं। ऐरोसॉल, कीटनाशक अथवा कोई अन्य उदाहरण लेते हुए इस विषय पर लिखिए। यह भी बताइए कि इसको किस प्रकार उपयोग किया जा सकता है?

विज्ञान, शिल्प विज्ञान और मानव

भूमिका

प्रातः काल उठने के तुरंत बाद से रात को सोने तक हमारे लिए विभिन्न प्रकार के उपकरण भिन्न भिन्न कार्य करते हैं। वह बिस्तर जिस पर हम सोते हैं, वह अलार्म घड़ी जो हमें जगाती है, वह गिलास जिसमें पानी है, वह पुस्तक जिसको हम सोने से पहले पढ़ रहे थे, सभी मनुष्य द्वारा बनाए गए हैं। चट्टानें, फल तथा फूल कुछ ऐसी वस्तुएं हैं जो प्राकृतिक रूप में मिलती हैं। कुछ अन्य वस्तुएं जैसे प्लास्टिक तथा ईंटें मनुष्य द्वारा बनाई गई हैं। इन वस्तुओं तथा पदार्थों ने हमारे जीवन को अधिक आरामप्रद तथा आनन्दमय बना दिया है। इन्होंने हमारी कुछ अन्य लाभकारी, जटिल और आवश्यक उपकरणों को बनाने की कुशलता भी बढ़ा दी है। यह ज्ञान और कुशलता पिछले कई हजार सालों से इकट्ठी हो रही है। आइए विज्ञान तथा शिल्प विज्ञान (प्रौद्योगिकी) के विकास की कुछ प्रमुख विशेषताओं पर विचार करें।

21.1 शिल्प विज्ञान तथा जीवन-परिवर्तन

पिछले अध्याय की तालिका 20.2 से ज्ञात होता है कि आदिकाल से 5000 वर्ष पूर्व तक प्रौद्योगिकी का किस प्रकार विकास हुआ। इसमें प्रत्येक प्रौद्योगिकी का एक मुख्य स्थान है। चाहे वह आग की खोज और उसका उपयोग हो, हथियारों का उपयोग हो या पशुपालन और कृषि। इसमें दो मुख्य बातें यह हैं--(1) प्रत्येक नई प्रौद्योगिकी से मनुष्य की जीवन चर्या तथा कार्य-कुशलताओं में परिवर्तन आता है, तथा (2) प्रत्येक प्रौद्योगिकी से किसी क्षेत्र के विकास की गति बढ़ती है। आइए कृषि के क्षेत्र से उदाहरण लेकर इन दो बातों का अध्ययन करें।

भोजन पौधों तथा जन्तुओं की मुख्य आवश्यकता है। लगभग 10,000 वर्ष पूर्व मनुष्य ने यह खोज कर ली थी कि कुछ विशेष प्रकार के पौधों को उगा कर भोजन का प्रबन्ध नियमित रूप से किया जा सकता है। कृषि की खोज से मनुष्य की जंगली पौधों से खाना एकत्रित करने की यायावर प्रकृति बदल गई। अब उसने समूह में रहकर खेती-बाड़ी द्वारा भोजन का उत्पादन करना प्रारम्भ कर दिया। इस प्रकार से कृषि की प्रौद्योगिकी का आरम्भ हुआ और इसमें सुधार होने लगे। आदिम-औजारों तथा साधारण

विधियों द्वारा आदि मानव केवल गेहूं तथा कुछ फलों के पौधे ही उगाते थे। पुरातन औजारों तथा साधारण तकनीकियों की सहायता से मनुष्य या कृषक नियमित भोजन की उपलब्धि करते थे तथा अन्य कई लाभ भी उठाते थे।

कृषि का मुख्य लाभ यह है कि मनुष्य को अपना भोजन प्रतिदिन जुटाना नहीं पड़ता है। वह वर्ष में कई बार फसल काट कर संग्रह करता है जिससे भोजन की उपलब्धि नियमित रूप से हो सकती है और वह निश्चिंत होकर अन्य कार्य कर सकता है। इसका अर्थ यह है कि मनुष्य को फसल उपजाने के साधन तथा संग्रहण की विधियों का विकास करना चाहिए। मनुष्य ने जल्दी ही कुटिया बनाना सीख लिया था जिसमें वह रह सकता था तथा भोजन का संग्रह भी कर सकता था। कृषि के क्षेत्र में खेतों में काम करने के लिए मनुष्य ने पशुओं को पालतु बनाया और उन्हें प्रशिक्षित भी किया। बैलों, घोड़ों तथा अन्य पशुओं के उपयोग से कृषि के उत्पादन में वृद्धि हुई। मनुष्य ने यह भी खोज की कि अनाज संग्रह को कीटों से किस प्रकार बचाया जा सकता है। मनुष्य को सदियों से ही यह ज्ञात था कि अनाज को कीटों से बचाने के लिए धूप में सुखाकर बबूल, नीम तथा अन्य पौधों का उपयोग करना चाहिए। कुछ वर्ष पहले महाराष्ट्र में पूना के निकट इनाम गांव में की गई खुदाईयों से यह पता चला है कि मनुष्य 3000 वर्ष से भी अधिक पहले संग्रहण की इन विधियों का इस्तेमाल करता था।

हमने कृषि के बारे में काफी चर्चा की है क्योंकि इस चर्चा से हमें कृषि के विभिन्न पहलुओं के बारे में ज्ञान प्राप्त होता है। ध्यान देने योग्य बात यह है कि प्रौद्योगिकी से विकास की दर बहुत बढ़ गयी है। इसके साथ अन्य विधियों तथा सहायक प्रौद्योगिकी का भी विकास हुआ। ये कुछ मुख्य पहलू हैं किसी भी बड़ी प्रौद्योगिकी के।

कृषि उद्योग से मनुष्य को एक महत्वपूर्ण संदेश प्राप्त हुआ है। इससे मनुष्य को पहली बार यह पता चला कि वह प्रकृति में भी हेर फेर कर सकता है। अब यह सम्भव हो गया कि मनुष्य किसी विशेष उद्देश्य के लिए योजना बनाकर पौधे उगा सके जैसे अनाज या सब्जियाँ। यह भी सम्भव हो गया कि पौधों को चारे के लिए उगाया जाए जो कि पालतू जानवरों के लिए उपयोग किया जाता है। पशुओं को पालतू बनाकर उसकी शक्ति को गाड़ी खींचने, हल चलाने पत्थर कूटने तथा कुएँ से जल खींचने के लिए इस्तेमाल किया जा सकता है। जंगली पौधे हमारी सम्पदा या संसाधन नहीं हैं जबकि फसलें हमारी सम्पदा हैं। जंगली जानवर भी सम्पदा या संसाधन नहीं हैं जबकि पालतू पशु हमारी सम्पत्ति हैं। प्रौद्योगिकी द्वारा किसी असंसाधन (Non resource) को संसाधन (Resource) में परिवर्तित किया जा सकता है। कृषि, खाद्य पदार्थों के उत्पादन की प्रौद्योगिकी है। इसमें बीज, पानी तथा मिट्टी संसाधन हैं। पशु पालन वह प्रौद्योगिकी है जिसमें पशु—जैसे दूध देने वाले पशु, भेड़, मुर्गी तथा अन्य पालतू जानवर संसाधन हैं।

हम यह देख चुके हैं कि जन समाज के विकास के साथ-साथ प्रौद्योगिकी का भी विकास होता है। प्रौद्योगिकी के लाभ से ही जन समाज के जीवन स्तर में सुधार आता है। इसके फलस्वरूप जब मनुष्य को व्यस्त तथा कठिन दिनचर्या से मुक्ति मिलती है और समय मिलता है तब वह नये विचारों की खोज करके उनका प्रयोग करता

है। इससे नई प्रौद्योगिकी का विकास होता है। जब कभी किसी नई प्रौद्योगिकी का इस्तेमाल होने लगता है तो मनुष्य के रहन-सहन के ढंग में परिवर्तन आ जाता है। इसके साथ उसमें ऐसे नए कार्य करने की क्षमता आ जाती है जो वह पहले नहीं कर सकता था।

प्रत्येक प्रौद्योगिकी की सफलता से किसी क्षेत्र के विकास की दर बढ़ जाती है। इससे ही गांव, शहर, प्रान्त तथा देश आदि बने हैं और उनका विकास हुआ है। किसी नई पद्धति को किस प्रकार स्वीकार किया जाता है? इस की स्वीकृति तथा सुधार इस बात पर निर्भर करता है कि इससे कार्य क्षमता में कितनी आसानी हो जाती है तथा कच्चा माल, ऊर्जा तथा अर्थव्यवस्था में कितनी उन्नति होती है। मनुष्य सदैव विभिन्न प्रकार के पदार्थों की खोज में रहता है जिन्हें वह नए साधनों में परिवर्तित करने का प्रयत्न करता है। ऐसा करने से नई प्रौद्योगिकी का विकास होता है। यदि हम अपनी सभ्यता के इतिहास पर दृष्टि डालें तो हमें पता चलता है कि हमने कितने प्रकार के पदार्थों का उपयोग किया है और हम पहले से ही कितने प्रकार की ऊर्जाओं को उपयोग में लाते रहे हैं।

21.2 प्रौद्योगिकी तथा विज्ञान की अन्योन्याश्रिता

आदि मानव कौन से पदार्थों का प्रयोग करता था। यह स्वाभाविक है कि उनका चयन प्रकृति से उपलब्ध लकड़ी तथा पत्थर तक सीमित रहा होगा। इस युग को "पाषाण युग" कहते हैं। यह कहना बहुत कठिन है कि यह युग विभिन्न सम्प्रदायों के लिए कब से कब तक रहा क्योंकि प्रत्येक महाद्वीप में मनुष्य ने पत्थरों के औजार बनाना अलग-अलग काल पर आरम्भ किया था।

इसके पश्चात् तांबे की खोज हुई। तांबे को आसानी से प्राप्त किया जा सकता है। तांबे की खानें खुले हुए गड्ढे के समान कम गहरी होती हैं। इसके साथ-साथ निम्न स्तर के जिस ताप को वह उस समय प्राप्त कर सकता था, तांबे को निकालने के लिए पर्याप्त था। तांबे का उपयोग खाना पकाने वाले तथा खाद्य संग्रहण के बर्तनों तथा औजार बनाने के लिये किया जाता था। तब से निरन्तर धातुकर्मी तांबे की अपेक्षा अधिक कठोर धातु मिश्रणों की खोज करते रहे तथा उन्होंने एक मिश्र धातु की खोज की जो तांबे से अधिकतम मजबूत थी। इसके फलस्वरूप ताम्र युग से कांस्य युग का विकास हुआ। तत्पश्चात् एक बहुत कठोर और शक्तिशाली धातु लोहे की खोज हुई। यह स्पष्ट है कि मानव इतिहास में धातुओं का एक बहुत बड़ा महत्व था क्योंकि उस समय युगों का नाम प्रयोग आने वाली वस्तुओं के नाम पर रखे गए हैं। जैसे "पाषाण युग", "ताम्र युग", "कांस्य युग" और "लोह युग"।

आप यह पढ़ चुके हैं कि किसी भार को कुछ दूरी तक विस्थापित करने को कार्य कहते हैं। जब हम किसी वस्तु को काटते अथवा निचोड़ते हैं तब भी कार्य होता है। कार्य करने के लिए ऊर्जा की आवश्यकता होती है। वास्तव में कार्य करने की क्षमता को ऊर्जा कहते हैं। वस्तुओं को गर्म करने के लिए भी ऊर्जा की आवश्यकता होती है। अतः भोजन पकाने के लिए भी ऊर्जा की आवश्यकता होती है। जैसे-जैसे मनुष्य की आवश्यकता बढ़ती

है वैसे वैसे ऊर्जा की खपत बढ़ती जाती है। हमें यह ऊर्जा कहां से प्राप्त होती है? प्रारम्भ में ऊर्जा का एकमात्र साधन मनुष्य की पेशीय ऊर्जा थी जिसकी पूर्ति वह भोजन द्वारा करता था। तदनन्तर उसने लकड़ी जलाकर आग उत्पन्न करना सीखा तथा पशुओं जैसे बैल, ऊंट, घोड़ा, हाथी आदि की पेशीय ऊर्जा को उपयोग में लाने के लिए इनको पालतू बनाना आरम्भ किया। यह जानना बहुत आवश्यक है कि ऊर्जा के स्रोत बहुत सीमित हैं।

इसके कुछ महत्वपूर्ण अपवाद भी हैं। मनुष्य ने वायु की ऊर्जा को उपयोग में लाना सीख लिया था। पाल नौकाओं के पाल को फैलाकर उन्हें पवन ऊर्जा से चलाया जाता था। इसका सिद्धान्त बहुत साधारण प्रतीत होता है। यह ध्यान देने योग्य बात है कि वायु सदैव उस दिशा में नहीं बहती है जिस दिशा में आपको जाना है। पालों तथा दिक् नियंत्रक (rudder) का कुशल उपयोग पाल नौकाओं को वांछित दिशा में चलाने के लिए बहुत आवश्यक है। बड़ी बड़ी नदियों के बहते पानी का उपयोग लकड़ी के लट्ठों को एक स्थान से दूसरे स्थान पर ले जाने के लिए किया गया। जल चाकों (water wheel) तथा पवन चक्कियों (wind mills) का भी आविष्कार हुआ तथा उन्हें उपयोग में लाया गया। इस तरह पानी के बहाव तथा वायु के वेग को एक संसाधन अथवा सम्पदा में परिवर्तित किया गया। अतः यह स्पष्ट है कि प्रौद्योगिकी का विकास विज्ञान के नियम तथा सिद्धान्तों को दैनिक जीवन में उपयोग करने से होता है। यही कारण है कि प्रौद्योगिकी को प्रायः व्यावहारिक विज्ञान कहा जाता है। प्रौद्योगिकी के विकास का स्तर वैज्ञानिक ज्ञान के स्तर पर आधारित है। विज्ञान की प्रत्येक नई खोज प्रौद्योगिकी के विकास में सहायक होती है। प्राचीन काल में हमारी वैज्ञानिक जानकारी तथा समझबूझ बहुत अधिक नहीं थी। यही कारण है कि कुछ सदियों पहले प्रौद्योगिकी का स्तर बहुत ऊंचा नहीं था। उस समय ऊर्जा के स्रोत भी केवल लकड़ी, वायु तथा पानी थे। कोयले की खोज एक बहुत ही महत्वपूर्ण सम्पदा सिद्ध हुई। यहां तक कि इसे "काला हीरा" कहा जाने लगा था। कोयले को जलाकर उपलब्ध ऊर्जा से इंजनों को चलाया जाता था। रेल के पुराने इंजनों में कोयले को जलाकर पानी से भाप पैदा की जाती थी। भाप के फैलने से पिस्टन तथा पहियों में गति होती थी। इसके पश्चात् पैट्रोलियम तथा प्राकृतिक गैस की खोज हुई। ईंधन के ये स्रोत कोयले की अपेक्षा अधिक सुविधाजनक तथा कार्य दक्ष थे। इनकी खोज के पश्चात् मोटर तथा इंजनों की प्रौद्योगिकी तथा यांत्रिक इंजीनियरी का विकास हुआ। नए इंजनों का आविष्कार किया गया जिनमें ये ईंधन उपयोग में लाए जा सकें। विद्युत तथा चुम्बकत्व की खोज से प्रौद्योगिकी में और अधिक उन्नति हुई। इसमें विद्युत इंजीनियरी और इलेक्ट्रॉनिक शिल्प विज्ञान (प्रौद्योगिकी) जैसे नए क्षेत्रों का विकास हुआ। परमाणु ऊर्जा का क्षेत्र हमें एक असीमित संसाधन प्रदान करता है।

मुख्य खोजों तथा आविष्कारों से नई प्रौद्योगिकी का विकास होता है। इनसे पूरे विश्व के समाज के विकास की दर में भी परिवर्तन होता है। जिस समाज ने आग जलानी सीख ली थी उसका विकास उनकी अपेक्षा जल्दी हुआ

जिन्होंने आग जलानी नहीं सीखी थी। खाना बदोशों की अपेक्षा कृषि प्रधान समाज का बहुमुखी विकास होता है। इसी प्रकार धातुओं की खोज तथा उनका उपयोग, बारूद की खोज तथा भाप के इंजन का आविष्कार मनुष्य के जीवन में बहुत महत्वपूर्ण घटनाएं हैं। जिस प्रकार प्रौद्योगिकी का विकास विज्ञान के आविष्कार से हुआ उसी प्रकार प्रौद्योगिकी के उपयोग से कई नई वैज्ञानिक खोजें हुई। इसका एक उदाहरण जेम्स वाट द्वारा आविष्कृत भाप का इंजन है। वाट के इंजन की सफलता के बाद उसके कई साथियों ने ऊष्मा तथा शक्ति के सम्बन्ध में सिद्धान्त दिए। उन्होंने इस प्रकार के प्रश्न पूछे कि "वाट का इंजन पुराने इंजनों की अपेक्षा क्यों अधिक कार्यक्षम है? किसी निश्चित मात्रा के ईंधन से अधिक से अधिक कितनी शक्ति प्राप्त की जा सकती है? शक्ति के संचरण में हानि को किस प्रकार बचाया जा सकता है? इन प्रश्नों के उत्तर से विज्ञान के एक नये क्षेत्र का विकास हुआ जिसे हम **थर्मोडायनमिक्स** (ऊष्मागतिकी) कहते हैं।

दूरदर्शी, प्रौद्योगिकी के विकास का एक दूसरा उदाहरण है। इस उपकरण का आविष्कार डैनमार्क के वैज्ञानिक ने किया था। परन्तु विज्ञान के लिए इसका उपयोग सर्वप्रथम इटली के गैलीलियो नामक वैज्ञानिक ने किया था। उसने दूरदर्शी का उपयोग आकाश को देखने के लिए किया तथा बृहस्पति के उपग्रहों, चन्द्रमा की विशिष्टताओं की खोज की। उसने खगोल विज्ञान की एक शाखा का 1609 में विकास किया।

तीसरा उदाहरण वर्तमान शताब्दी से है। लगभग 50-60 वर्ष पहले अमेरिका के गोडार्ड तथा जर्मनी के बान ब्रान ने द्रव ईंधनों का प्रयोग करके राकेट विकसित किए। द्वितीय महायुद्ध (1939-1944) के समय जर्मनी के प्रयासों से एक ऐसे राकेट का आविष्कार हुआ जिससे हथियारों को कई हजार किलोमीटर की दूरी तक भेजा जा सकता था। इन्हें V-2 राकेट कहते थे और उनसे अन्तरिक्ष युग प्रारम्भ हुआ। उसके पश्चात् राकेट विज्ञान में बहुत उन्नति हुई है। आज ऐसे राकेट उपलब्ध हैं जिनके द्वारा अन्तरिक्ष वाहनों को अन्तरिक्ष में विभिन्न ग्रहों तथा गैलेक्सियों मे भेजा जा सकता है। 1969 में अमेरिका के नील आर्मस्ट्रांग तथा एडविन एल्ड्रिन चन्द्रमा पर पहुंचे तथा अपने साथ वहां की मिट्टी तथा पत्थर लाए। अतः 360 वर्षों (10 पीढ़ियां) में चन्द्रमा का अध्ययन दूरदर्शी की अपेक्षा सूक्ष्मदर्शी में परिवर्तित हो गया।

21.3 शिल्प विज्ञान कितनी तेजी से विकसित होता है और कितनी जल्दी अपनाया जाता है

तालिका 21.1 को देखिए जिसमें ईसवी 1800 तक लगभग 3000 वर्ष में प्रौद्योगिकी का विकास दिखाया गया है। तालिका से यह स्पष्ट है कि सन् 1500-1800 के बीच प्रौद्योगिकी का विकास पहले की अपेक्षा तेजी से हुआ। इसका क्या कारण है? प्राचीन काल में आविष्कार, औजारों का उपयोग या उनका बनना आकस्मिक घटना थी। उस समय प्रयोगाश्रित विधि उपयोग में लाई जाती थी जिसमें वैज्ञानिक सिद्धान्तों का पूरी तरह स्पष्टीकरण नहीं था। यह संभव है कि वैज्ञानिक सिद्धांतों का स्पष्टीकरण तब हुआ जब यह जानने की कोशिश की गई कि किसी विधि या आविष्कार ने ऐसा रूप क्यों धारण किया।

तालिका 21.1

1000 ईसापूर्व तथा सन् 1800 ई. के बीच प्रौद्योगिकी का विकास

काल	*प्रौद्योगिकी*	*उपयोग करने वाला वर्ग/देश*
600 ईसा पूर्व	पत्थर की चक्की से अनाज पीसना	–
350 ईसा पूर्व	कपास को कातकर धागे बनाना	भारतीय तथा ग्रीक–कपड़े के लिए
300 ईसा पूर्व	लकड़ी के बने गियर, घिरनी तथा पेंच	ग्रीक, रोमन–पानी खींचने तथा भारी वस्तुओं को उठाने के लिए
100 ईसा पूर्व	फलों का रस निकालने के लिए पेंच वाली मशीन, लोहे के पहियों का रथ	ग्रीक और सेल्ट–युद्ध के लिए
ई. सन् 300 से 500	कीमिया, कांच, जलचक्की और सिल्क पदचालित मशीनें कागज खगोल शास्त्र	अरबों, यूरोपियों, चीनियों द्वारा ग्रीक, मिस्र में, भार उठाने के लिए चीन में ग्रीक, भारतीय (टोलेमी, सूर्य–सिद्धांत)
ई. सन् 500 से 1000	नावें, चुम्बकीय दिक् सूचक पवनचक्की गणित सड़कों के नक्शे तथा सड़क निर्माण खगोलीय परिकलन	वाइकिंग, चीनी चीन, पर्सिया भारत (महावीर) रोम भारत (आर्यभट्ट से भास्कर तक)
ई. सन् 1000 से 1250	कांच बनाने की फैक्ट्रियां धातु विज्ञान मार्बल की टाइप से छपाई	इटली यूरोप चीन
ई. सन् 1250 से 1500	हाथ करघा तथा मशीन की खड्डी कीमिया	चीन भारत

	यांत्रिक घड़ियां	यूरोप
	छापे खाने	जर्मनी
	तोपें तथा हथियार	चीन
ई. सन् 1500 से 1750	ज्यामिती की सहायता से भूमि सर्वेक्षण	यूरोप
	खनिज विज्ञान	जर्मनी (एग्रिकोला)
	सूक्ष्म जीव विज्ञान (कीटाणुओं की खोज)	पश्चिमी यूरोप
	गतिविज्ञान, चुम्बकीय, विद्युत विश्लेषिक ज्यामिती	यूरोप
	सूक्ष्मदर्शी तथा उसका उपयोग	हालैंड
	आगनात्मक तर्क	फ्रांस (दकार्ते)
	दूरदर्शीय तथा खगोल विज्ञान	हॉलैंड तथा इटली
	गुरूत्वाकर्षण सिद्धांत, कैलकुलस	इंग्लैंड (न्यूटन)
	भाप का इंजन	इंग्लैंड
	रसायन विज्ञान	इंग्लैंड (बॉयल)
	थर्मामीटर, इलेक्ट्रोस्टैटिक मशीन	यूरोप
ई. सन् 1750 से 1800	कपड़ा बुनने की मशीन, लाइट हाउस, पानी के ऊपर लोहे के पुल, निर्वात पम्प, विद्युत के लिए वोल्टा सेल, वाट का भाप का इंजन, सड़क पर चलने वाली भाप की गाड़ियाँ।	इंग्लैंड, यूरोप

इन प्रयोगात्मक प्रयत्नों से विज्ञान की नींव पक्की होती गई। विज्ञान की विधियों के विकास के लिए एलहाजन (11वीं शताब्दी), रोज़र बेकन (13वीं शताब्दी), फ्रांसिस, बेकन, कोपरनिकस, गैलीलियो (16वीं तथा 17वीं शताब्दी) इन सभी को श्रेय जाता है। उन्होंने अवलोकन तथा सिद्धान्तों के प्रयोगात्मक सत्यापन पर बल दिया। विज्ञान की विधि पर आधारित कई नियमों का स्पष्टीकरण हुआ और पूर्वानुमान लगाना संभव हो सका। अब विधि का उपयोग अथवा औजारों का विकास तर्क संगत तथा क्रमबद्ध रूप से होने लगा। अब प्रौद्योगिकी का विकास केवल प्रयागाश्रित प्रयत्न न रहकर विज्ञान के विनियोग से विकसित किया जा सकता है।

जैसे जैसे विज्ञान का विकास और अधिक

प्रसार हुआ वैसे वैसे उसके उपयोगों की संख्या तथा दर भी बढ़ती गई। 19वीं शताब्दी तक विज्ञान तथा प्रौद्योगिकी की अन्योन्याश्रिता स्थापित हो चुकी थी। इससे तकनीकी आविष्कारों में क्रान्तिकारी विकास हुआ। जैसे ही विज्ञान के किसी सिद्धान्त की खोज हुई वैसे ही आविष्कारकों ने यह प्रश्न पूछा कि इसका क्या उपयोग है? किसी प्रौद्योगिकी अर्थात् शिल्पविज्ञान के विकास में कई वैज्ञानिक सिद्धान्त एक साथ उपयोग में लाए जा सकते हैं। इससे कई नए तथा जटिल अनुप्रयोग सम्भव हुए। तालिका 21.2 में इसके कई उदाहरण दिए गए हैं। खान में उपयोग में आने वाले डेवी के सुरक्षा लैम्प की खोज में कई सिद्धान्त जैसे ऊष्मा संचरण, प्रकाश संचरण, सुरक्षा विधियों, धुएं का निष्कासन आदि से संबद्ध सिद्धान्तों का उपयोग हुआ। विद्युत जनित्र तथा विद्युत बल्ब के विकास में यांत्रिक इंजीनियरी, ऊष्मा संचरण आदि कई सिद्धान्तों का उपयोग किया गया।

ऊर्जा के नए स्रोतों की उपलब्धि के पश्चात् अमेरिका तथा यूरोप में कई नए उद्योग धन्धे आरम्भ हुए। इनमें स्टील, रेलें, कपड़ा, परिवहन तथा विद्युत की वस्तुएं प्रमुख हैं। उद्योग से क्या होता है? आइए इसे समझने के लिए एक कपड़ा उद्योग पर विचार करें। कपड़ा धागों द्वारा बनता है। धागे करघे में तैयार किए जाते हैं। हाथ से चलने वाले करघे में कारीगर (अपनी पेशीय ऊर्जा से) दिनभर में केवल कुछ ही मीटर कपड़ा तैयार कर सकता है परन्तु विद्युत शक्ति का इस्तेमाल करके ऐसी मिलें बनाई जा सकती हैं जिनमें प्रतिदिन कई हजार मीटर कपड़ा तैयार किया जा सकता है। किसी फैक्ट्री अथवा उद्योग में वस्तुओं का उत्पादन बड़े पैमाने पर किया जा सकता है। वस्तुओं के अधिक उत्पादन का लाभ यह है कि हमें उसी प्रकार की वस्तु सस्ते दामों पर उपलब्ध हो जाती है। यूरोप में 18वीं तथा 19वीं शताब्दी की औद्योगिक क्रांति से यही हुआ। यह क्रांति किस प्रकार संभव हुई? इसके कुछ मुख्य कारण इस प्रकार हैं:— मशीनों को चलाने के लिए ऊर्जा के नए स्रोत, विज्ञान के कई मूल सिद्धान्तों की उत्पत्ति, पदार्थों के उत्पादन में विज्ञान के सिद्धान्तों का प्रयोग तथा वस्तुओं का अधिक मात्रा में उत्पादन जिससे गुणवत्ता अच्छी रहे तथा कीमतों में कमी आए।

उद्योग द्वारा वस्तुएं अधिक मात्रा में तथा कम कीमत पर उपलब्ध कराई जा सकती हैं। इसमें कच्चे माल की बहुत अधिक आवश्यकता पड़ती है। किसी परिवार द्वारा हथकरघे में प्रतिदिन केवल कुछ किलोग्राम धागा ही इस्तेमाल होता है। परन्तु किसी फैक्ट्री में प्रतिदिन कई टन धागे की आवश्यकता होती है। अतः उद्योग में कच्चे माल की आवश्यकता बहुत अधिक पड़ती है। यूरोप में सारे कच्चे माल का उत्पादन नहीं होता था। इसलिए यूरोपीय देशों का ध्यान एशिया तथा अफ्रीका के देशों की ओर गया जहां कच्चा माल बहुत अधिक मात्रा में उपलब्ध था। परिणामस्वरूप उन्होंने इन देशों पर अधिकार कर लिया। भारत के नक्शे में उन क्षेत्रों

को देखिए जहां कपास, पटसन, तथा टीक की लकड़ी का उत्पादन होता है। "ईस्ट इण्डिया कंपनी" ने इन क्षेत्रों को अपने अधिकार में कर लिया था। यह कंपनी भारतवर्ष से कच्चे माल को बहुत सस्ते दामों पर खरीदकर इंग्लैंड भेज देती थी। कच्चे माल से उत्पादित वस्तुओं को भारतवर्ष में ही अधिक दाम पर बेचा जाता था। इस प्रकार भारत से इंग्लैंड को दो प्रकार से लाभ हुआ – (1) कच्चे माल का स्रोत (2) उत्पादित वस्तुएं जैसे– कपड़ा, साबुन इत्यादि के लिए मंडी या बाजार।

कच्चे माल को बेचने से बहुत अधिक धन प्राप्त नहीं होता है। जब कच्चे माल से कुछ नई वस्तुएं बना दी जाती हैं तो उन्हें बेचकर अधिक धन प्राप्त किया जा सकता हैं। उदाहरण के लिए गेहूं लगभग 3 रुपये प्रतिकिलो बेचा जाता है परंतु जब उससे ब्रेड बनाकर बेची जाए तो दोगुनी कीमत मिलती है। लोह अयस्क बहुत सस्ते दाम पर मिलता है लेकिन उसी से बना स्टील बहुत मंहगा होता है। भारत में लोहा तथा मैग्नीज अयस्क अधिक मात्रा में उपलब्ध है। क्या हमें इन अयस्कों को बेचना चाहिए? या हमें इनसे केवल वस्तुएं बना कर बेचनी चाहिए?

तालिका 21.2

प्रौद्योगिक तथा औद्योगिक क्रांति (1800 से 1900)

काल	*प्रौद्योगिकी*	*प्रयोग*
1800 से 1805	भाप से चलने वाली नाव	युद्ध तथा संचार
	भाप से चलने वाली रेलें तथा इंजन	परिवहन
1815	पत्थर तथा गटर की सहायता से मैक ऐडम सड़कों का निर्माण	सड़क, परिवहन
1825	डेवी का तार की जाली से बना लैम्प	खदानों में सुरक्षित लैम्प
	डिब्बों में सुरक्षित मांस	भोजन का संरक्षण
	थेम्स नदी के नीचे सुरंग	परिवहन
1830 से 1850	लोहा (पीटवा)	इंजीनियरिंग भवन निर्माण
	जल टरबाइन	इंजीनियरिंग
	बल्कनित रबड़	परिवहन

	टेलीग्राफ का आविष्कार	संचार
	फोटोग्राफी	संचार
	पोर्टलैंड सीमेंट	उच्च कोटि की भवन निर्माण सामग्री
1850 से 1880	संश्लेषित रंग	वस्त्र
	कृत्रिम सिल्क (रेयन)	वस्त्र
	स्टील का उत्पादन	उद्योग, भवन, इंजीनियरिंग
	तेल की खोज (पेट्रोलियम)	ईंधन, युद्ध
	विद्युत जनित्र	इंजीनियरिंग
	विद्युत बल्ब	इंजीनियरिंग, ऊर्जा
	भाप की टरबाइन	इंजीनियरिंग, परिवहन
	डाइनामाइट	सुरक्षित विस्फोटक, युद्ध
	टंकण मशीन (Typewriter)	संचार
1880 से 1900	खेती बाड़ी में अधिक उत्पादन	भोजन की आवश्यकता
	बहुमंजिली इमारतें	आसान निर्माण
	डीजल इंजन	इंजीनियरिंग, परिवहन
	पेट्रोल, इंजन	इंजीनियरिंग, परिवहन
	सिनेमा प्रक्षेपित्र	संचार

औद्योगिक क्रांति से एक नया युग प्रारम्भ हुआ। प्रत्येक क्षेत्र में कई आविष्कार हुए। भाप के इंजन से रेलों तथा बड़े जहाजों का विकास हुआ जिनमें वायु तथा पालों की आवश्यकता नहीं होती थी। जब पेट्रोल उपलब्ध हुआ तो ऐसे हल्के इंजन बनाए गए जो बहुत शक्तिशाली थे। इन इंजनों का प्रयोग राइटब्रदर्स ने 1903 में हवाई जहाज को उड़ाने के लिए किया। आजकल बड़े वायुयानों का उपयोग बहुत सामान्य हो गया है।

आजकल कई नए पदार्थ जैसे स्टेनलैसस्टील, प्लास्टिक, नॉईलान तथा अन्य धातुओं के मिश्रण बनाए जा चुके हैं। ऐसी कई नई औषधियों की खोज की जा चुकी है जिनसे मृत्यु दर बहुत कम हो गई है। पहले बहुत से मनुष्य मलेरिया, चेचक, इन्फ्लूएंजा तथा टी.बी आदि जैसी बीमारियों से मर जाते थे। आजकल इन बीमारियों का इलाज हो जाता है।

संचार एक और ऐसा क्षेत्र है जिसमें प्रौद्योगिकी के कारण बहुत विकास हुआ है। मुद्रणयंत्र (Printing Press) का आविष्कार 1448 में जर्मनी में हुआ। आजकल पुस्तकें बहुत अधिक संख्या में छपती हैं तथा वे काफी कम कीमतों में उपलब्ध हैं। मुद्रण यंत्र के आविष्कार से पहले पुस्तक की प्रत्येक प्रति हाथ से लिखी जाती थी। टेलीग्राम, रेडियो तथा अब टेलीविजन से हमें समाचार बहुत जल्दी प्राप्त हो जाते हैं। इन आविष्कारों से पहले समाचार तथा पत्र मनुष्यों द्वारा ले जाए जाते थे। इसलिए समाचार केवल उतनी तेजी से ही पहुंच सकता था जितनी तेजी से

वाहक चल सकता था। अब समाचार रेडियो तरंगों द्वारा प्रसारित होते हैं। रेडियो की तरंगें प्रकाश की चाल से चलती हैं। वे एक सेकंड में पृथ्वी के सात चक्कर लगा सकती हैं।

तालिका 21.3

1900 से अब तक 80 वर्षों का प्रौद्योगिक विकास

द्वितीय औद्योगिक क्रांति

1900 से 1910	प्लास्टिक का निर्माण (बैकलैंड द्वारा बैकेलाइट 1906) बीमारियों का रसायनों द्वारा उपचार (कैमोथेरेपी, अहर्लिच 1907) कारों का विशाल उत्पादन (एसेम्बली लाइन विधि, T मॉडल की कारें, फोर्ड 1908) इंजन द्वारा चलाए जाने वाले हवाई जहाज (राइट बंधु 1903)
1910 से 1920	रेडियो तथा बेतार संचार के लिए निर्वात ट्यूब या वाल्व (फ्लेमिंग 1904, 1912) पटरी पर चलने वाले वाहनों का विशाल उत्पादन, बड़ी नहरों का निर्माण (50 मील लम्बी पनामा नहर 1914)
1920 से 1930	रेडियो प्रसारण नेटवर्क (1922) द्रव ईंधन का उपयोग करके पहले राकेट का निर्माण (गोडार्ड 1926) संसार की सबसे ऊंची इमारत (न्यूयार्क की एम्पायर स्टेट बिल्डिंग, 102 मंजिलें, 1930)
1930 से 1940	टेलीविज़न का आविष्कार (बेयर्ड 1936) गैस टरबाइन इंजन (व्हिटल तथा चेन 1937) बांध बनाकर जल विद्युत शक्ति का उत्पादन (बोल्डर बांध द्वारा दस लाख किलोवाट विद्युत का उत्पादन 1936) संश्लेषित कपड़ा, नायलॉन का निर्माण (कैरोथर्स–1939) डी.डी.टी. कीटनाशक का निर्माण (मुलर–1940)
1940 से 1950	प्रतिजैविक दवाइयां (पेनिसिलिन, फ्लेमिंग और फ्लोरे, 1942) प्रथम परमाणु शृंखला अभिक्रिया (फर्मी इत्यादि 1942) प्रथम परमाणु बम (अमेरिका 1945) ध्वनि की गति से तेज चलने वाला हवाई जहाज (1947) ट्रांजिस्टरों का आविष्कार (1948) प्रथम इलेक्ट्रॉनिक कम्प्यूटर (1946)
1950 से अब तक	परमाणु शक्ति संयंत्र (1952)

अंतरिक्ष की खोज (स्पुतनिक, रूस, 1957)
उपग्रह द्वारा दूर संचार (1970 का दशक)
जैव प्रौद्योगिकी (1975)
व्यक्तिगत कम्प्यूटर (1980 का दशक)

आप देख सकते हैं कि प्रौद्योगिकी का विकास किस प्रकार हुआ। तालिका 21.3 में इस शताब्दी के महत्वपूर्ण विकास (द्वितीय औद्योगिक क्रांति) दिए गए हैं। पिछले 50 वर्षों में यह विकास बहुत तेजी से हुआ है। 1950 में रेडियो का आकार बहुत बड़ा होता था। उनमें निर्वात नलिकाएं होती थी तथा घरेलू विद्युत लाइन आवश्यक थी। रेडियो बहुत ही कम लोगों के पास थे। बड़े गांवों व छोटे कस्बों में कुछ गिने-चुने रेडियो थे। जब ट्रांजिस्टर का विकास हुआ तो पाकेट रेडियो बहुत अधिक संख्या में बनने लगे। आजकल छोटे से गांव में भी बहुत से रेडियो उपलब्ध हैं तथा उन्हें एक स्थान से दूसरे स्थान पर आसानी से ले जाया जा सकता है।

आप यह भी देखेंगे कि आजकल नई प्रौद्योगिकी को अपनाने में और व्यापक पैमाने में प्रयोग करने में बहुत अधिक समय नहीं लगता है। प्राचीन काल में नई प्रौद्योगिकी का व्यापक पैमाने पर उपयोग होने में बहुत समय लगता था। उदाहरणार्थ, माचिस का आविष्कार 19वीं शताब्दी के मध्य में हुआ। लेकिन इसका व्यापक उपयोग होने में लगभग 70 वर्ष लगे। जबकि सर हम्परी डेवी द्वारा आविष्कृत सुरक्षा लैम्प यूरोप की खानों में केवल 10 वर्षों में व्यापक रूप से इस्तेमाल किया जाने लगा था। आजकल किसी प्रौद्योगिकी के विकास तथा उसके अपनाने में बहुत कम समय लगता है।

प्रौद्योगिकी को अपनाने में कम समय लगने का क्या कारण है? सर्वप्रथम बात यह है कि किसी प्रौद्योगिकी का विकास आवश्यकता पड़ने पर ही किया जाता है। उदाहरणार्थ, जैव प्रौद्योगिकी द्वारा रक्त तथा अन्य सैम्पलों के विश्लेषणों की सही विधि विकसित हो गई है। इससे कई बीमारियों की जानकारी प्राप्त की जा सकती है। इनमें से कई तो सरलता से इस्तेमाल करने के लिए किट के रूप में उपलब्ध हैं। रक्त के विश्लेषण की आवश्यकता बहुत बार होती है और इन किटों द्वारा यह विश्लेषण सफलतापूर्वक किया जा सकता है। इसके अतिरिक्त प्रौद्योगिकी से मनुष्य की कार्यक्षमता और आर्थिक लाभ होना चाहिए। प्लास्टिक इसका एक उदाहरण है। प्रौद्योगिकी से हमें खाना बनाने तथा संग्रहण के लिए प्लास्टिक के बर्तन उपलब्ध हैं। इनका रख रखाव आसानी से किया जा सकता है। ये बर्तन सस्ते मिलते हैं तथा आसानी से टूटते या नष्ट नहीं होते हैं। ये भार में हल्के होते हैं तथा धातुओं की अपेक्षा ऊष्मा के कुचालक होते हैं। संक्षेप में हम यह कह सकते हैं कि ये टिकाऊ हैं और सस्ते भी हैं। यही कारण है कि इनका प्रयोग गाँव में भी किया जाने लगा है। तीसरे प्रौद्योगिकी की जानकारी आसानी से, शीघ्र तथा विस्तारपूर्वक उपलब्ध होनी चाहिए। आज से लगभग 40 वर्ष पूर्व भी किसी जानकारी को पृथ्वी के विभिन्न भागों में पहुंचने तथा समझने में बहुत समय लगता था। परंतु संचार तथा यातायात की व्यापक सुविधाओं से अब संसार भर में समाचार कुछ ही सेकंड में पहुँच जाते हैं। प्राचीन काल की अपेक्षा अब

प्रौद्योगिकी को अधिक तेजी से अपनाया जा सकता है। प्रौद्योगिकी को जल्दी अपनाने के मुख्य कारण इस प्रकार हैं – (1) आवश्यकता की पूर्ति (2) इस्तेमाल करने में आसानी तथा कार्य क्षमता (3) विधि से आर्थिक लाभ (4) प्रौद्योगिकी के बारे में तेजी से जानकारी।

इन्हीं कारणों से कोई प्रौद्योगिकी दूसरी प्रौद्योगिकी का स्थान ले लेती है। जब रासायनिक उर्वरकों का उत्पादन अधिक मात्रा में होने लगा तो उन्होंने खेतों में खाद का स्थान ले लिया। जब वाहनों का आविष्कार हुआ तो उन्होंने बैल गाड़ियों का स्थान ले लिया। अब सड़क के वाहनों तथा पानी के जहाज की अपेक्षा हवाई जहाज अधिक प्रचलित हो गए हैं। 40 वर्ष पहले रेडियो निर्वात नलिकाओं से बनाए जाते थे तथा उनका आकार बड़ा होता था। ट्रांजिस्टर तथा एकीकृत परिपथों के आविष्कार के बाद हम जो रेडियो खरीदते हैं, वे बहुत सस्ते, भार में हल्के, बहुमुखी तथा ऐसे होते जिनमें पुर्जों को बदलने की आवश्यकता बहुत कम होती है।

21.4 नई प्रौद्योगिकी, नई आवश्यकताएं

लगभग 100 वर्ष पूर्व तक अरब का प्रायद्वीप गरीब था तथा आर्थिक रूप से विकसित नहीं था। वहाँ पेट्रोलियम की खोज के पश्चात् तेल की प्रौद्योगिकी विकसित हुई और उस प्रायद्वीप में क्रांति हुई। आज साउदी अरब, कुवैत तथा यू.ए.ई. (U.A.E) संसार के सबसे अधिक अमीर देश हैं। लोगों की आवश्यकताएं तथा रहन सहन के ढंग बदल गए हैं। तेल की प्रौद्योगिकी की कई आवश्यकताएं हैं। कच्चे तेल को एक स्थान से दूसरे स्थान पर ले जाने के लिए बहुत लंबी पाइप लाइन की आवश्यकता होती है। तेल शोधक कारखानों में विद्युत शक्ति तथा अन्य सुविधाओं की आवश्यकता होती है। सड़कें, हवाई अड्डे तथा बन्दरगाह आधुनिक तथा कार्य कुशल होने चाहिए। संसार के अन्य देशों से संचार सम्प्रेषण के अच्छे साधन होने चाहिए। इन देशों में अन्य देशों तथा सभ्यताओं के लोग कार्य करने तथा धन कमाने के लिए आए हुए हैं। इन सब चीजों के होने के कारण यहाँ के निवासियों के रहन-सहन का ढंग, समाज तथा उनकी परम्पराओं में बदलाव आया है। फलस्वरूप हर आदमी की आवश्यकताओं तथा अभिरूचियों में बदलाव आया है। उदाहरणार्थ, वे सब अपार्टमेंट्स तथा फ्लैट्स में रहते हैं, स्कूटरों तथा गाड़ियों का इस्तेमाल करते हैं। रसोईघर में खाना पकाने की गैस उपयोग में लाते हैं और संश्लिष्ट (synthetic) कपड़े पहनते हैं। घर की आवश्यकताओं की वस्तुएं प्रतिदिन न खरीदकर सप्ताह में एक बार खरीदी जाती हैं। सब्जियों तथा मांस को लम्बे समय तक ताजा रखने के लिए रेफ्रीजरेटर का उपयोग किया जाता है। घरों में आराम से रहने तथा गर्मी सर्दी से बचने के लिए कूलर, वातानुकूलक तथा हीटर उपयोग में लाए जाते हैं। मनोरंजन के लिए रेडियो तथा टेलीविजन बहुत लोकप्रिय हो गए हैं।

इस प्रकार के परिवर्तन तथा नई आवश्यकताएं भारत के गांवों में भी देखी जा सकती है। भवन-निर्माण की नई सामग्रियों की उपलब्धि के पश्चात् अब गांवों के बहुत से घर सीमेंट तथा लोहे के बने हुए पाए जाते हैं। इसी प्रकार अब रसोई घर में कोयले तथा लकड़ी के चूल्हों के स्थान पर मिट्टी के तेल के स्टोव तथा खाना पकाने की गैस अधिक प्रचलित हो गई है।

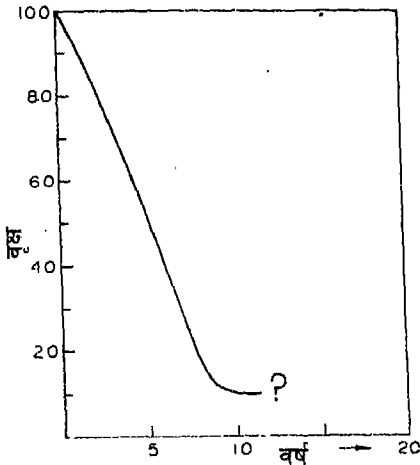
गांव के लोगों की आवश्यकताएं तथा रुचियां बदल गई हैं। वे नई प्रौद्योगिकी के फलस्वरूप मिलने वाले आराम, सुविधा और मूल्यों से प्रभावित हो चुके हैं। अब प्रौद्योगिकी का प्रभाव प्रत्येक मनुष्य पर पड़ रहा है। किसी एक प्रौद्योगिकी के उपयोग से दूसरी प्रौद्योगिकी के उपयोग की आवश्यकता महसूस होने लगती है। इसका प्रभाव हम गांव के जीवन पर भी देख सकते हैं। उत्तम बीजों के उपयोग से फसलें अच्छी होने लगी हैं। इस कारण यह आवश्यक हो गया है कि अनाज के संग्रहण तथा बचाव के लिए नई प्रौद्योगिकी का उपयोग किया जाए। अनाज को रेल, ट्रक, पानी के जहाजों द्वारा दूर-दूर तक पहुंचाया जाए। इसके लिए गांवों में अच्छी सड़कें, अधिक विद्युत, सिंचाई के अच्छे साधन और सहायक उद्योगों की आवश्यकता होगी।

21.5 सिक्के के दो पहलू

हम पहले यह देख चुके हैं कि पिछले कुछ वर्षों में प्रौद्योगिकी का विकास बहुत तेजी से हुआ है। परन्तु प्रौद्योगिकी के उपयोग के प्रभाव की समझ बहुत धीरे-धीरे आ रही है। अब एक और बात जो हमने महसूस की है वह यह है कि प्रौद्योगिकी के कारण कच्चे माल की खपत बहुत तेजी से होती है। इसका प्रभाव यह है कि हमारे कच्चे माल के स्रोत बहुत तेजी से समाप्त हो रहे हैं। आइए इसे समझने के लिए दो उदाहरणों पर विचार करें।

कपास, कपास के पौधे से प्राप्त होती है जिसे प्रत्येक वर्ष उगाया जाता है। यदि कपड़े की मिलें वर्ष भर के रूई के उत्पादन को छह महीने में ही समाप्त कर दें तो क्या होगा? शेष छह महीने कपड़ा मिलें बंद होंगी। चूंकि हमें फैक्ट्री तथा उसमें कार्य करने वाले कर्मचारियों का भरण-पोषण पूरे वर्ष करना होगा। इसलिए कपड़ा कुछ महंगा हो जाएगा। यदि दोगुने क्षेत्र में कपास उगाने का निर्णय करें तो क्या होगा? सभी तरह की भूमि खेती के लिए उपयुक्त नहीं होती। हमारे इस निर्णय का प्रभाव यह होगा कि वह भूमि जिस पर हम गेहूं तथा ज्वार जैसी फसलें उगाते हैं, कपास उगाने के काम में आएगी। इससे कपड़ा मिलें तो पूरे वर्ष कार्य कर सकेंगी परन्तु इसके साथ साथ खाने की कमी हो जाएगी। यह निर्णय हमें लेना है कि क्या हम भूखे रहें और अच्छे कपड़े पहनें। इस प्रकार के प्रश्नों के उत्तर आसान या साधारण नहीं हैं। एक एकड़ जमीन पर कपास उगाना, गेहूं उगाने की उपेक्षा अधिक लाभकारी होगा (क्योंकि कपास गेहूं से महंगा है)। जो किसान इन समस्याओं पर विचार नहीं करते हैं उन्हें भोजन से ज्यादा कपास उगाने का प्रलोभन रहता है। यही कारण है कि यहां राष्ट्रीय प्राथमिकता की योजनाओं की आवश्यकता होती है।

किसी एक वन का उदाहरण लीजिए। वन अमूल्य सम्पत्ति है। इनसे भवन तथा फर्नीचर के लिए कीमती लकड़ी प्राप्त होती है, जलाने के लिए लकड़ी प्राप्त होती है तथा कई अन्य चीजें जैसे लाख तथा रेज़िन प्राप्त होते हैं। शक्तिशाली मशीनों की उपलब्धि से पहले मनुष्य दिन में अधिक से अधिक एक या दो वृक्ष काट सकता था। अब वह मशीनों की सहायता से एक दिन में सैकड़ों वृक्ष काट सकता है। क्या हमें इस प्रकार वृक्ष काटने चाहिए? आइए इसके एक साधारण पहलू पर विचार करें। मान लीजिए किसी एक वन में सौ वृक्ष हैं। हम प्रति वर्ष दस वृक्ष काटते हैं

और दस वृक्ष लगा देते हैं। मान लो एक वृक्ष को बढ़ने में दस वर्ष लगते हैं। चित्र 21.1में किसी वन में एक वर्ष में पूरी तरह से बढ़े हुए वृक्षों का ग्राफ दिखाया गया है। ग्राफ में प्रत्येक वर्ष में वृक्षों की संख्या दिखाई गई है। वृक्षों को काटने तथा पुनः लगाने का परिणाम क्या होता है ये भी दिखाया गया है। इसका परिणाम यह होगा कि 10 वर्ष के बाद वन में केवल 10 वृक्ष होंगे। यह तो तब हुआ है जबकि हमने उतने ही पेड़ और लगा दिये थे जितने कि हमने काटे थे। तब ऐसा क्यों हुआ? हम यह भूल गए कि वृक्ष को बढ़ने में 10 वर्ष लगते हैं। जितने वृक्ष हमने काटे थे, हमें उससे अधिक वृक्ष लगाने चाहिए थे।

चित्र 21.1 ऐसे वनों का अध्ययन जिनमें वृक्ष काटे जाते हैं और फिर से लगाये जाते हैं।

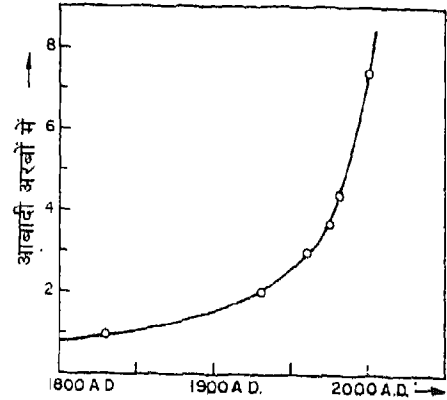
वन जैसी राष्ट्रीय सम्पत्तियों के विकास में समय लगता है। हजारों वर्ष पूर्व पृथ्वी के अंदर वृक्षों के दबने से कोयला बना था। इसका अर्थ यह हुआ कि कोयला तथा खनिज तेल (पेट्रोल) जिन्हें अब हम इस्तेमाल कर रहे हैं उनके बनने में लाखों वर्ष लगे हैं। इसका अर्थ यह भी हुआ कि फिर से कोयला बनाने में प्रकृति लाखों वर्ष लेगी। यदि हम इस सम्पत्ति को कुछ ही शताब्दियों में समाप्त कर दें तो क्या होगा?

केक को आप बचा भी सकते हैं और खा भी सकते हैं

प्रौद्योगिकी किसी असंसाधन को संसाधन में बदल सकती है। ऐसी बहुत सी विधियाँ हैं जिनके द्वारा वातावरण का संतुलन बनाए रखकर अपशिष्ट पदार्थों को सम्पत्ति में बदला जा सकता है। उदाहरणार्थ पशुओं का मल बहुत निम्न स्तर का संसाधन है। गोबर को उपले बनाकर ईंधन के रूप में इस्तेमाल किया जा सकता है अथवा गड्ढे में दबाकर खाद में परिवर्तित किया जा सकता है। गोबर गैस संयंत्र द्वारा गोबर को ऐसी गैस में परिवर्तित किया जा सकता है जो खाना पकाने तथा प्रकाश के लिए काम आ सकती है। यह गैस एक बहुत अच्छी किस्म का ईंधन है। जलने पर इसकी लौ नीली होती है तथा इसका ताप भी बहुत अधिक होता है। गैस प्राप्त होने के पश्चात् संयंत्र में बचे अवशेष से उत्कृष्ट खाद प्राप्त होती है। गोबर गैस संयंत्र उच्च कोटि के शिल्प विज्ञान (प्रौद्योगिकी), का एक उदाहरण है। यह अपशिष्टों को पुनः सम्पत्ति में बदल देता है तथा वातावरण को भी प्रदूषित नहीं करता।

इस सिद्धान्त से हमें एक बहुत ही सरल शिक्षा मिलती है। किसी सिक्के के दोनों पहलुओं को देखना चाहिए। यह निश्चित ही है कि प्रौद्योगिकी किसी असंसाधन को संसाधन में

परिवर्तित कर देती हैं। परन्तु हमें यह भी देखना चाहिए कि क्या वह किसी संसाधन को व्यर्थ की वस्तु में तो नहीं बदल रही है? हर जगह कपास उगाने से हमारे खाद्य उत्पादन में कमी हो जाएगी। पानी तथा उर्वरकों के अंधाधुंध इस्तेमाल करने से हमें कुछ वर्षों तक भरी-पूरी फसल प्राप्त हो सकती है, परन्तु आने वाले कुछ वर्षों में भूमि में लवण की अधिकता होने के कारण वह खेती के लिए बेकार हो जाती है। इसके साथ-साथ यदि सम्पदा को प्राप्ति की दर की अपेक्षा अधिक दर पर व्यय किया जाए तो भी वह बहुत हानिकारक होगा। हमें ऐसे संसाधनों को तो और भी ध्यान से उपयोग में लाना होगा जो फिर प्राप्त नहीं किये जा सकते। ऐसी सम्पदाओं को अनवीनीकृत (Non-reneweble) संसाधन कहते हैं।

पिछले दो सौ वर्षों में विज्ञान तथा प्रौद्योगिकी का बहुत विकास हुआ है। प्रौद्यौगिकी को प्रयोग में लाने के लिए उसे सीखने में समय लगता है। आइए इसके एक उदाहरण पर विचार करें। द्वितीय महायुद्ध के पश्चात् अर्थात् 1945 के पश्चात् बहुत सी नई औषधियों का आविष्कार हुआ। अब प्लेग, निमोनिया, टी.बी., चेचक, मलेरिया आदि बीमारियों का भी इलाज किया जा सकता है। पहले की अपेक्षा अब ऑपरेशन अधिक सुरक्षित हो गया है। अब प्रतिजैविक (एन्टिबायोटिक) दवाइयों की सहायता से संक्रामक रोगों का उपचार किया जा सकता है। बच्चे का जन्म अब निश्चित तौर पर सुरक्षित है। इसका अर्थ यह हुआ कि अब मृत्यु दर कम हो गई है। इन औषधियों के आविष्कार से पहले संसार की जनसंख्या लगभग स्थिर थी तथा मृत्यु दर और जन्म दर बराबर थे। अब मृत्यु दर कम हो गयी है। अब यदि जन्म दर पहले जितनी रहेगी तो जनसंख्या बहुत तेजी से बढ़ जाएगी। चित्र 21.2 में यह दिखाया गया है कि संसार की जनसंख्या वर्ष 1830 से किस प्रकार बढ़ी है। उस समय यह 1 अरब थी जो अगले सौ वर्षों में दोगुनी हो गयी तथा वर्ष 2 हजार तक यह 8 अरब हो जाएगी।

चित्र 21.2 *इस शताब्दी में संसार की जनसंख्या में अत्यधिक वृद्धि।*

आइए एक वृत्ताकार झील का उदाहरण लें। इसमें कुछ पौधे तथा मछली जैसे कुछ जन्तु हैं। उस झील में पौधे तथा जन्तु तब तक हंसी खुशी से रह रहे थे जब तक कि उनके मध्य में एक नया पौधा नहीं उगा था। इस पौधे में कुछ विशेष गुण थे। इसकी वृद्धि इतनी तीव्र थी कि प्रतिदिन इसकी संख्या दोगुनी हो जाती थी। इसके अतिरिक्त यह जिस क्षेत्र में उगा हुआ था उसमें ये किसी भी और प्रकार के जीव को पनाह नहीं देता था। आप इसे कब देखेंगे। शायद तब जब कि वह काफी बड़ा हो गया होगा। मान लो आपने इसे तब देखा जब

कि एक चौथाई झील इससे भर गई थी। यह निश्चित ही है कि दो दिन के बाद इससे पूरी झील ढक जाएगी और यह बाकी सभी सजीव वस्तुओं को मार देगा। इसके लिए हमें क्या करना चाहिए। मान लो हमें ऐसी प्रौद्योगिकी उपलब्ध है जिसके द्वारा हम झील के क्षेत्रफल को 10 गुना बढ़ा दें (यह कोरी कल्पना ही है। वास्तविकता यह है कि हम झील के क्षेत्रफल को 10 गुना तो क्या 10 प्रतिशत भी नहीं बढ़ा सकते।) अगर हम ऐसा कर भी पाएं तो उसके बाद भी हमारी समस्या का समाधान नहीं होगा। आप यह देख सकते हैं कि इस बढ़ी हुई झील को भी यह नाशक पौधा केवल तीन दिन में ही भर देगा। यदि हम इस झील को 1 घंटे में 10 गुना बड़ा कर दें फिर भी हम झील के सजीवों को नहीं बचा पायेंगे।

जब कोई वस्तु इस गति से बढ़ती है कि किसी निश्चित समय (मान लो एक दिन या एक वर्ष) में वह दोगुनी हो जाए तो ऐसी बढ़ोतरी को चरघातांकी वृद्धि (exponential growth) कहते हैं। यदि आप इस प्रकार के संबंध को किसी ग्राफ पेपर पर प्रदर्शित करें तो आप यह देखेंगे कि वृद्धि की गति कितनी तेज है।

$y=2^x$ का ग्राफ खींचो। x - के मान 1, 2, 3, 4 लीजिए और y के प्राप्त मानों को ध्यान से देखिए।

अब आप समझ सकते हैं कि प्रदूषण इतनी बड़ी समस्या क्यों है? जब उद्योगों के अपशिष्टों को वातावरण में छोड़ दिया जाता है तब उसके दो प्रभाव होते हैं। इन प्रभावों को समझने के लिए आइए कुछ उदाहरण लें।

1. कोई भी उद्योग प्रदूषित पानी को (जिसमें विषैले पदार्थ हों) नदियों में बहा देते हैं।	नदी में पौधे तथा जीव मर जाते हैं तथा वे पौधे जो प्राकृतिक स्वच्छता बनाए रखते हैं नष्ट हो जाते हैं। इससे पानी पीने योग्य नहीं रहता है।
2. उद्योगों से निकले हुए हानिकारक धुएं को वायु में छोड़ दिया जाता है।	यह वायु श्वसन लेने के लिए अनुपयुक्त हो जाती है। धुआं पौधों में इकट्ठा हो जाता है और उनकी वृद्धि को रोक देता है। कुछ अवस्थाओं में तो यह जीवन को भी नष्ट कर सकता है। ऐसी घटना हमारे देश में कुछ वर्षों पहले भोपाल में हुई थी।

वातावरण का संतुलन एक बार बिगड़ने के पश्चात् फिर से ठीक करना बहुत कठिन और कभी-कभी तो असंभव हो जाता है। वे वैज्ञानिक तथा प्रौद्योग वैज्ञानिक जो इस समस्या के विषय में जागरूक हैं, लोगों को इस बात की शिक्षा दे रहे हैं कि हमें प्रदूषण को रोकना चाहिए।

प्रश्नावली

1. विभिन्न प्रकार के प्राकृतिक संसाधन कौन-कौन से हैं? क्या आप किसी ऐसी टेक्नालॉजी (प्रौद्योगिकी) का नाम बता सकते हैं जिसका उपयोग इन सभी संसाधनों में किया जाता है?
2. अनवीनीकृत संसाधन किन्हें कहते हैं? चार उदाहरण दीजिये।
3. प्रत्येक प्रमुख प्रौद्योगिकी किसी लघु प्रौद्योगिकी को जन्म देती है तथा उसके विकास में सहायता करती है। इस कथन को कृषि तथा वस्त्र उद्योग के संदर्भ में समझाइये?
4. किसी नई प्रौद्योगिकी को तुरंत अपनाये जाने में कौन-कौन सी बातें मुख्य भूमिका निभाती हैं?
5. चित्र 21.1 की सहायता से निम्नलिखित प्रश्नों के उत्तर दीजिये:
    1. 15 वर्ष के बाद वृक्षों की संख्या कितनी होगी?
    2. 150 वर्ष के बाद वृक्षों की संख्या कितनी होगी?
    3. मान लीजिए हम 10 के स्थान पर 20 वृक्ष प्रतिवर्ष की दर से लगायें परन्तु 10 वृक्ष प्रतिवर्ष काटना जारी रखें तो ग्राफ कैसा दिखाई देगा? ग्राफ खींचकर दिखाइये।
6. चित्र 21.2 के ग्राफ के स्लोप को किस प्रकार कम किया जा सकता है? क्या इसे इतना कम किया जाना संभव है कि वह क्षैतिज रेखा के समान्तर हो जाय? ऐसा करने के लिए कुछ विधियों का सुझाव दीजिये?

CHAPTER V

THE ASSESSMENT OF INTELLIGENCE IN YOUNG CHILDREN

How do we Estimate Children's Development and Ability?

Whenever we watch even two or three children of about the same age playing together, we begin to compare one with another. Usually these comparisons are direct:

" Mary is taller than Jean "; or " Tom is more active than Neville "; or " Jill makes more noise than all the other four put together."

On the whole, a group of adults will tend to agree in their observations on this simple level, though they may add some qualifying remarks, such as:

" Neville is not himself to-day "; or " Jill is excited because her daddy is coming home," implying that what can be seen at this moment is not characteristic of the children always.

Sometimes we make more generalized judgments, implying comparison with an outside standard, as when we say:

" They are all very big children, except Jean "; or " They all talk well for their age "; or " They are very sensible although Tom is sometimes babyish for a boy of his age."

When this kind of judgment is made, there is often disagreement among the observing adults. One will say:

" But I've seen many children who are much bigger at this age "; another, " I don't think their speech is very forward; they use a lot of words but they make little attempt at sentences "; a third may add, " I don't like noisy children! "

Frequently, too, discussion of children's present behaviour leads to prediction of their future development: "Neville will hold his own; he knows what he wants and doesn't let Tom boss him"; or "Jill is so anxious to find out about everything; she's an intelligent child and will go a long way."

It will be seen that in making such comparisons and judgments much depends on:

1. Our general knowledge and experience of children.
2. Our knowledge and experience of other children of the age of those we are observing.
3. Our previous knowledge of these children ("Neville is not himself").
4. The acuteness of our observation ("They don't make sentences").
5. Our attitude to children and their behaviour ("I don't like . . .").

In Nursery and Infant Schools, teachers and others are continually making comparisons and judgments and rightly so. Every teacher wants to be sure that the opportunities provided for all children and the special help given to particular children are meeting their present needs and laying reliable foundations for their future development. Day-to-day observation and deepening knowledge of every member of a class are indispensable, so are an awareness of the pattern of progress and an atmosphere which promotes all-round growth. In her efforts to give children the opportunities and stimulus they need, every teacher is, in a general sense, a child psychologist. But in trying to estimate those needs most adults know only too well that their experience is limited and their standards biased by their knowledge and outlook. Moreover, the very freedom of a good Nursery School and the consequent wide range of activity to be found there, excellent though these conditions are, can be mis-

leading. It is much easier to compare children when they are all doing the same thing, *at* the same time, and *in* the same time, than when they are all busily but diversely occupied in working at their own interests. The writer has noticed that teachers in the more formal type of Infant School are often much more dogmatic about children's abilities than their colleagues working along more modern lines. This is partly because the latter show greater humility and respect for children but partly because the children's achievement in set tasks can be *measured* more exactly.

The Need for Standardized Scales

What is needed to help in day-to-day estimates of children's needs and potentialities is some kind of "measuring instrument" which will make these judgments more reliable. No scale is ever likely to be made that will tell us everything about a child, because personality and intelligence are not simple qualities, like height, to be measured along a simple yardstick. The standardized tests and scales to be described below do not take the place of personal observation but they are helpful when teachers set out to compare certain aspects of children's behaviour and development with what appears, from the study of large numbers of children, to be "normal" for their age. They are also a useful corrective to personal bias. Individual judgments are inevitably subjective, coloured to a greater or less extent by feelings. Most people, perhaps, tend to overestimate those they like and to undervalue in some way those who do not appeal. A teacher may over-compensate when she feels sorry for one child and incline to be harsh in her demands and expectations of another who seems to be favoured by fortune. These human reactions to children are not "wrong" but they can be misleading, and, in the long run, are not always in the children's interest.

So, as Dr. Stutsman says: "The most effective tool the child psychologist has is his knowledge of children, subjective though it be; but this knowledge functions more freely and effectively when it is supplemented by tools which enable the psychologist to determine a child's level of development. Any device that renders real assistance in this problem of determining the level of development is of value, but the cruder and more inaccurate tools are of much less value than the refined and accurate ones. Standardized tests of all types fall into the classification of useful tools."[1]

The Pioneer Work of Binet in France

Although this is not the place to describe in detail the technique of making scales and tests, it is interesting to note the general unfolding of the idea of mental measurement applied to young children.

The first intelligence test to be used at all widely with children was devised by Binet and published in 1905. Its aim was the separation of feeble-minded from normal children. Later, Lewis Terman, working on the revision of Binet's tests in America, extended their use by applying them to the separation of supernormal from normal children. Many subsequent revisions have made them a more precise instrument of measurement; on the whole, their main use is to estimate children's educability.

Binet made his scale on the principle of "sinking shafts into the mind at as many points as possible." Consequently, tests based on his scale consist of a number of "mixed" items. Among other ideas which psychologists and teachers owe to the genius of Binet are certain concepts which later workers have extended. One of these is "mental age," suggesting that children pass through successive levels of mental growth. This led to

[1] R. Stutsman: *Mental Measurement of Pre-school Children.* (World Book Coy., 1931.)

the evolution of a further useful term, "intelligence quotient," by Stern, enabling a direct comparison to be made between one child's rate of development and probable adult level of intelligence with another's.

The Development of Special Scales for Young Children

Scales based on Binet's original one can be used with children under six, but most psychologists prefer some of the later scales which have been developed from detailed studies of young children themselves. Not only do these seem more "natural" for pre-nursery and nursery school ages; they are actually founded on an extension of the idea of what we can and should try to measure during this period. In the words of Dr. Charlotte Bühler, herself a brilliant contributor to our understanding of how children develop, investigators in this field have tended to "shift from emphasis on the intellectual level to one of total behaviour."[1]

There are two types of "measuring tool" for young children; the developmental scale and the test of ability and intelligence. In using a developmental scale, the general procedure is to watch children's behaviour at home or in a nursery, and to compare it with the "developmental norm" for children of that age. In using an intelligence test, little situations are arranged and a comparison is made between children's responses and the "norm." In both scales and tests, some special apparatus must be used. If one of the items is to complete a picture puzzle, the puzzle presented must always be the same and introduced in the same way, otherwise the situation is different. There is, of course, overlapping between scales and tests. A developmental scale usually involves

[1] C. Bühler and H. Hetzer: *Testing Children's Development from Birth to School-Age*. English translation by Henry Beaumont. (George Allen and Unwin, 1932.)

some very simple apparatus, such as teething-rings and toy bricks. A good test, or perhaps one should say a good tester, allows some free use of the apparatus by the child, but only *in addition* to the directed activity.

In recent years there have been a number of experiments in scales and tests for young children. Here the most complete and widely used of each will be described.

GESELL'S DEVELOPMENTAL SCALES

Arnold Gesell, as a result of prolonged and profound observation of young children in the Guidance Nursery of the Yale Psycho-clinic, published in 1925 and 1928 developmental scales applicable to children from one month to three years. He took as his starting-point the natural movement of children and their response to their human and other environment. He watched closely and recorded, from work with large numbers of babies, the age at which most of them showed certain patterns of behaviour. He noted, for instance, that at three months most children smile responsively when one smiles at them, but that they do not turn their heads at a voice or a bell until two months later. Again, at seven months, most babies will pick up a cube from a table, but not until they are ten months will they accept a second cube without first dropping the one they are already holding.

From such detailed studies, Gesell was able to throw considerable light on what is meant by growth in general and mental growth in particular. "Growth denotes a capacity to change, in a constructive, progressive form from one level of performance to another. . . . Mental growth is a constant process of transformation and reconstruction."[1]

Gesell arranged his 1928 scale so that children's behaviour could be recorded under four main headings

[1] Arnold Gesell: *Infancy and Human Growth.* (The Macmillan Company, 1928.)

representing "cross-sections of the behaviour tree at ascending levels of growth."[1] These cross-sections are:

1. Motor development, which includes a baby's growing control and use of his own body, from the earliest attempts to lift his head for a moment to the co-ordination of muscular activity needed for going upstairs or drawing with a pencil.

2. Language, that is, understanding as well as use of voice and words. Stages are noted, ranging from the earliest purposeful cries to fully articulate and syntactical speech.

3. Adaptive behaviour, which may be summarized as a child's response to whatever stimulates him in his environment, and ranges from giving fleeting attention to a moving object to the older child's attempt to imitate any adult action which has caught his interest.

4. Personal-social behaviour, a child's use of the opportunities of his environment, including his response to other human beings. At two months, for example, he will kick in his bath of his own accord, at three months he will begin to play with his own fingers, at five months he can distinguish between strangers and those whom he knows and at nine months he will wave good-bye.

These four cross-sections, taken together, give a fairly comprehensive picture of a child's behaviour. Because they are based on the continued study of many children they can, when applied to any one child, give at least an indication as to whether he is average, advanced or retarded for his age. This does not mean that any child necessarily shows equal development under all four headings, and indeed a nursery school would be a dullish place if this were so. But it does mean that in any one of those four aspects of behaviour there is no "transposition

[1] Gesell: *Op. cit.*

of events." Every baby goes through the three months stage of motor development, for instance, before he reaches the four months level; or, expressed the other way, no baby exhibits the four months pattern *before* he has shown the three months. Whether a child is average, subnormal or supernormal in his growth, that growth tends to be consistently average, subnormal or supernormal, unless there is some very outstanding circumstance to interfere with that child's natural rhythm. It will be noted that this is a confirmation of Binet's "mental age" as representing orderly, individual progress.

The Merrill-Palmer Scale of Tests

Gesell's work is intended to help in the assessment of pre-nursery school children. The most attractive and widely used test for children between two years and about six and a half is that standardized at the Merrill-Palmer School in Chicago, and described in *Mental Measurement of Pre-school Children* by Rachel Stutsman.

This test is the result of considerable research. In its final form, the scale consists of thirty-eight subtests, some of them adaptations of earlier tests by other workers. It is an intelligence test, in the usual sense of the term, and differs from Gesell's scale in that it sets out definitely to estimate children's ability rather than to present a picture of their behaviour level, which indicates but does not measure ability as such. But as the Merrill-Palmer test involves a long individual interview, during which the examiner establishes a rapport with the child and watches his responses to a variety of situations, the result is more than a mere mental age assessment. "The scale places a child in an experimental situation in which we can compare his responses to those of many children in the same situation. The sum total of the child's reaction is significant. . . . It is not enough to get the mental

test score when at the same time we might have a much more valuable measure of that entity, the responding child."[1]

The test items are arranged in order of difficulty and grouped to represent six-monthly levels of development, beginning at eighteen months. Thus tests 1 to 11 indicate the average achievement of children between eighteen and twenty-four months; tests 12 to 21 the achievement of children between twenty-four and thirty months, etc. Some of the tests appear in the scale once only, others are timed and the more quickly a child finishes these, the higher the level at which he scores. Each test counts as one point and the child's mental age is calculated from the total score. As children under six, especially in a test situation, are at least likely to refuse to co-operate from time to time, adjustments are made on the score so that every refusal does not count as a failure.

WHY IS THE MERRILL-PALMER TEST ATTRACTIVE TO BOTH CHILDREN AND EXAMINERS?

First, because it is essentially a performance test; that is, the child spends most of his interview busily touching, moving and experimenting with brightly coloured objects out of gaily coloured boxes.

Secondly, the tasks are interesting in themselves. Fitting pegs into holes, doing "puzzles" of all kinds, building with bricks, sorting colours and matching pictures are activities which appeal to all children. Attempts to imitate an adult's finger movements calls forth a laughing response from some children, and many, though by no means all, like answering questions, showing how grown-up they are with words.

Thirdly, there is variety of activity. Children are rarely

[1] Stutsman: *Mental Measurement of the Pre-school Child.*

bored or restless during this test. Indeed, it is the common experience of psychologists in clinics that difficult under-fives often begin by being tearful or obstinate and end by refusing to go home or be parted from the test material.

Lastly, the test is well scaled, so that the child is introduced to the more difficult tasks gradually and the examiner has the satisfaction not merely of watching progress through these stages, but also of challenging and correcting her own first subjective estimate.

The Value of Standardized Procedure

In giving this or any other properly standardized test, the examiner is bound to follow a fairly rigid routine, and to mark by established scoring standards. Tasks are presented in a certain order and in certain words ; what shall be accepted as " right " or " wrong " is also carefully laid down. But these restrictions, if rightly understood, bring both confidence and peace. There is no need for the tester to worry as to whether any particular task is " suitable " for a child being tested. Neither has she to decide what response a child ought to give or how his response should be evaluated. And at the end there is an estimate of how the child being examined compares with others of his age in performing tasks which require intelligence.

The very standardization of the procedure, moreover, brings a compensating freedom. A test interview makes it possible to compare children, not merely children's results. As experience in testing increases, similarities and differences can be noted. It is not always possible to interpret a child's present response in terms of his future development, but, as the history of the making of standardized tests shows, accurate observation is the necessary foundation of later interpretive work. Dr.

Stutsman emphasizes the same point: "We realize that every movement a child makes in the test situation is conceivably significant, if only we had the key. The pre-school child in a test situation offers a fascinating field for personality observations."[1]

Children's attitudes to adults, to themselves, to success and failure, to frustration, encouragement and praise often show with remarkable clarity in a test interview, and give valuable guidance as to their needs. Molly's mother and her teacher (who allowed no free activity in school, by the way), considered her backward. A test showed that she was well above the average, but so self-critical that she hardly dared to try to do anything at all. She had a brother of four and a half, a year her junior, who was considered much brighter. Their mental levels were actually the same, but Molly's attitude to herself was preventing her from showing what she could do.

Peter, just two, liked the test but refused to do anything by request or persuasion. He would imitate the examiner's block tower or bridge, but if she *asked* him to build one he swept the apparatus on to the floor with a lordly gesture and demanded "anither box." He would not answer any questions when they were put to him. The examiner asked hopefully from time to time, "What does a doggy say?" He pursed his lips and remained aggressively silent. But half an hour after she last asked, he flung his arms round her neck and bellowed into her ear, "The doggy says 'BOW-WOW-WOW.'" Peter's prevailing attitude was obstinacy, natural enough in a two-year-old but becoming in him a fixed character quality because of unwise handling. Celia, aged three and a half, lowering under her mop of dark, unbrushed curly hair, was considered unmanageable by her long-suffering parents. It was, indeed, difficult to test her, because she went one better than Peter. She not only

[1] Stutsman: *Op. cit.*

refused to do anything if she were asked, but insisted that the examiner should do it instead. She shouted in a deep, gruff voice, " You do it, lady; go on, you do it." This went on for a long time, until a quiet, firm refusal, in a later interview, brought a dramatic change. Her face cleared and she said with almost a sigh of relief: "Auntie, I'll do all the washing-up for you." Here was a child who needed some protection from her own aggressive impulses. She was not, in fact, so much an unmanageable child as one who had never been helped, by wise restraint, to deal with the normal childhood conflict between primitive impulse and the demands of a civilized environment.

Training for using Individual Tests with Young Children

An individual test is really a standardized interview and interviewing is an art. It will be clear from the examples quoted above that the use and interpretation of tests, for young children in particular, demand both knowledge and skill. Well-constructed scales, such as the two described in this chapter, are published with manuals of minute directions for administering the tests and well-defined scoring standards. But testing technique and skill cannot be wholly learned from a book. Although it is a scientific procedure, based upon scientific findings, it is also an art passed on from the experienced to those who are new to it. Testers who have undertaken training after they have been testing are surprised to realize, retrospectively, how many mistakes and therefore miscalculations even a sensible person can make.

At present, individual tests are used by educational psychologists, by school medical officers, and by teachers. The first of these have, ordinarily, a degree in pyschology, teaching experience and a special training in child

guidance. School medical officers, in addition to their medical qualifications, have usually attended special courses in mental testing. Some local education authorities arrange courses in testing for experienced teachers who are interested.[1] The essence of all such training courses, long or short, is that they include in addition to lectures and discussions on the theory of testing, both demonstrations with children and supervised practice. It is the last which cannot be got from the most carefully prepared manual.

The Place of Individual Testing in General Educational Practice

Intelligence testing is usually associated with particular educational services; child guidance, for instance, and selection procedures for children of eleven plus.

All children attending Child Guidance Clinics are given an individual test, because knowledge of a child's intellectual assets and liabilities helps to determine both diagnosis and treatment. A very bright truant is likely to absent himself from school for quite different reasons from those tempting a very dull boy to stay away.

When children are being selected for one or other kind of secondary education, it is obviously necessary to estimate or review their abilities and interests.

But standardized scales are of distinct value in general educational practice, beginning in the nursery school. Their use here is educational guidance, and this is true whether the testing is actually done by an educational psychologist or by a member of the school staff, properly

[1] In general it is not advisable for young teachers, in their first three years of professional life, to undertake such training. Their background knowledge of children is too thin and testing technique, prematurely acquired, tends to foster a mechanistic approach to children.

trained.[1] On the whole, it is probably true to say that if an educational psychologist is available, it is usual to ask him to test, partly so that an outside opinion is obtained to compare with the teacher's. Moreover, it is extremely difficult for anyone, whatever her qualifications, to be objective when testing a child whom she knows quite well. Even the most conscientious teacher is likely to be influenced in her assessment of a child's response by her previous knowledge of his abilities and attitudes. Many kindly teachers object to their children being tested by a stranger on the ground that this is a frightening situation. But the art of putting even frightened children at their ease is part of the equipment of every well-trained psychologist, and provided they are properly reassured, many children will reveal interests, attitudes, fears and prejudices which they guard jealously from those who see them every day and whose attention they have to share with thirty or forty others. Such " revelations " are, of course, largely unconscious ; if a child feels confident of a sensible stranger's interest, he will let himself play, work and talk without the minimum of restraint.

In any case, whoever does the testing, teachers and psychologists will discuss the findings and work out a plan of action, whether this be referral to a clinic or modification of school treatment or teaching method.

On What Principles should Children be Selected for Testing ?

Individual testing must be unhurried and each child takes at least an hour to test. It will be long before there

[1] The school medical officer's function in ascertaining the children who require what is technically known as " Special Educational Treatment " is not discussed here, because attention in this chapter is focused on educational matters within the school rather than with administrative aspects.

is time to test all children before they are seven, so that some selection must be made. In general, the children about whom it is difficult " to make up our minds " are the problems on whom testing may throw some light.

Children who appear to be backward should be tested before they begin formal work in the three R's. In the course of examining some hundreds of children of between eight and twelve, the writer has been struck by their attitude of defeat, depression or defiance. Many a tough lad has assued her either that he does not want to read or that "nobody can't teach me, miss." These attitudes seem to be related to earlier rather than present failure and discouragement; by the time they are eight, many backward children have given up trying. If a child is given a test at five or six and is found to be well below the average in intelligence, formal work should be postponed until he is more mature and therefore better equipped for acquiring the very complex skills of reading and number. The extra time spent on informal activities is well *spent*; it is not wasted, since it enables a child to gain mastery over the simpler skills, muscular control, speech and elementary number awareness without which it is impossible for him to learn the more complex. The child whose time is being *wasted* is the one who is trying to do what he is too immature to do, in body, mind and spirit.

It is often helpful to test a child about whom parents are anxious. Some parents feel they must push their children on. If a test result suggests that a child is average or bright, parents can be reassured and will often then relax their efforts. If, however, subnormality is indicated, the teacher or psychologist will need both tact and sympathy in explaining that it is to the child's interest to let him develop at his own rate.

Children showing serious behaviour difficulties should be referred to a Child Guidance Clinic as early as possible.

But where this service is not available, or when the difficulty is a mild one, a test may be given. A very retiring child, for instance, will sometimes show interests and aptitudes which are not suspected even by his teacher, because he remains passive amid the general activity of a group of noisy and perhaps self-assertive children. Armed with more precise knowledge than observation of him in a group could give, the teacher can now plan more effective help. In contrast, a restlessly aggressive child sometimes proves to be inferior in intelligence ; his difficult behaviour arises from boredom. He frequently fails to understand the purpose of the activity of his group and cannot take in or remember instructions which would help him to make what he wants. When she knows that he is, in spite of his clamorous and self-important behaviour, actually a slow child, the teacher can temper both her teaching and her reproofs !

Children who cannot or will not speak, are a particular challenge to any teacher. It is not advisable to take any action about such a child until he has had ample time to settle into school. But as not speaking can be a sign of retardation, a child who remains inarticulate should be tested. Sometimes the diagnosis of retardation is confirmed by a general poor performance ; sometimes such a child will show that he is by no means dull though he may well be mildly or seriously maladjusted.

Standardized tests, used judiciously, and supplemented by day-to-day observation and understanding of children, and by consultation with school medical officers and psychologists, can add to understanding of backward and difficult children. That is, they play a part in educational guidance almost from the beginning of a child's school life.

Have the Results of Intelligence Tests given to Children under Six any Permanent Significance?

This question is the subject of many heated arguments not unclouded by prejudice on one side or both!

A well-standardized test, based not on ideas of what children ought to be able to do at certain ages but on what they can actually do, should be able to show fairly reliably how a child compares with other children of his age—if it is given by a trained person.

Unless there are special environmental circumstances affecting a child's natural rate of development, the result of such a test as the Merrill-Palmer, given before a child is six, is likely to be confirmed by the results of tests given later in his school life, if these are equally well standardized and well administered. But in no case are even good tests likely to give *exactly* the same result and sometimes substantial differences will occur. It must be remembered that although the tests are called tests of intelligence, intelligence itself is a very elusive quality to try to measure. No definition has yet been found that satisfactorily covers all its manifestations. Moreover, in relation to young children in particular, no one yet knows enough about the factors which affect a child's *use* of his natural endowments to be sure that any test really measures potential ability.

So that, for purposes of long-term educational guidance, for the keeping of cumulative records, intelligence tests should be given three or four times during a child's school career. An intelligence rating should never be regarded as absolute, as something fixed and almost magic. It should be understood for what it actually is: a method of expressing the result of a child's performance in a particular test in terms of the "normal" performance for his age. (Incidentally, an intelligence quotient recording should always be accompanied by the name of the test on which it was calculated.)

The Education Act of 1944 makes certain provisions and recommendations which call for increasing skill in assessing children's all-round development. The provisions for secondary education alone call for instruments of selection which teachers and administrators do not in fact possess. Education according to "age, ability and aptitude" means being able to calculate the abilities and aptitudes as well as the ages! And even if that were possible, there would still be those variations of temperament and character which affect the use of natural abilities, to reckon with.

Long-term records of large numbers of children are needed before it will be possible to rely on the prognostic and diagnostic value of any test used. Some at least of these studies can begin in the nursery school and be based on the comparison of nursery school findings, both tests and general observations, with the later careers and interests of the children.

CHAPTER VI

SPEECH

When the child learns to talk it is as though he finds a key that unlocks a new phase of his development, for speech is a means to, as well as an indication of, the remarkable psychological growth that begins at about one year and a half and increases in vigour during the next four or five years. The cooing of a contented baby is as instinctive as the midsummer sound of doves, his cries of want as elemental as the roaring of young lions which " do lack and suffer hunger." Facial expression becomes very mobile from about two months and by five months it is quite clear that the baby's smiles express very early feelings of relationship to the people who care regularly for him, more especially the mother. Here indeed is the nucleus of the wish to communicate. By six months he is capable of syllabic utterance—la la, dad, ga ga. Observation shows how very pleasurable his early babbling is to the baby. For a time he seems just to be enjoying his own sensations and the new feel of making meaningless sound. Quite soon however this babbling differentiates itself into expressions of recognizable emotions, eagerness, pleasure, displeasure and even scolding noises. Some observations by Dorothy Burlingham and Anna Freud suggest that there is often a further differentiation of sounds to express some special feeling which the child attaches to beloved people. They describe a child of nine months who developed a special chuckling noise which she kept exclusively to show her pleasure in her mother. At eleven months this gave place to particular

grumbling noises which expressed a new turn in the child's attitude to the parent—a special demanding relationship. In a nursery crowded with adults and other children these sounds were never used except for the mother. Long before speech has any cognitive significance therefore it would seem that the more primitive significance of expressing the child's emotions. These are obviously deeper and more compelling where the relationship to his mother is concerned. The importance of the child's feelings for the mother cannot therefore be underestimated in their effect on even the primitive elements of speaking.

Infantile babbling is characteristic of children of every race, Eskimo, Chinese, Negro, European, who make substantially the same sounds : and it occurs even in children born deaf which proves that it is independent of hearing or imitation. Karl Bühler calls it the vocal stone quarry of the human language. Lewis who has made a very careful phonetic study of these early sounds says " when the child begins to utter labial and dental consonants which are phonated sucking-movements, states of discomfort are represented by m and n forms, states of comfort by p, b, d, t forms."[1] Though individual children vary, labials and dentals seem to come more easily to the child; l, th; hissers or buzzers s, z; the more complicated ch, dge, etc., later. A similar classification of vowel sounds according to mechanical difficulty also emerges from a study of this early babbling. This gradual mastery of the production of vocal sounds suggests that later forms of speech-training should follow a similar progression, for the facility acquired in this early period is often submerged by later difficulties of hearing and imitation when the child adopts conventional

[1] M. Lewis: *Infant Speech.* (Kegan Paul, Trench, Trubner and Co.)

language. Rodney Bennett in *First Stages of Speech Training*—also in *Play Way of Speech Training* arranges his jingles and rhymes on this principle with the sensible proviso that such jingles should possess a quality of interest for the age at which they are used. Traditional rhymes and tongue twisters have their value here and every enterprising nursery school teacher can make an anthology of her own.

Babbling Passes into Speech

Between six and nine months the second stage of progression, focusing of attention and intelligence, can be observed in the child's advance upon significant speech. Certain syllables have assumed meaning by the interpretation put upon them by those in charge of the child and he begins to listen and even to imitate certain sounds which lie close to his natural babbling. " Speech grows out of impulses of the most primitive nature. . . . At first the sound expressions are still embedded in the more diffuse activities of these impulses and only by degrees free themselves as independent acts."[1] Goodenough suggests in *Developmental Psychology* that the incomprehensible babbling of the younger child passes over into true speech not so much by a process of extension as by the one of limitation. The process is similar to that followed by the child in established muscular co-ordination, for he learns gradually to isolate specific sounds from general babble and to use them to express specific wants. " From the babbling of infancy develop the word forms that the child is able to produce at will. . . . Thus he learns to talk." The child attaches no meaning at first to his imitations though in many children repetition of heard speech is so pronounced that

[1] Stern: *Op. cit.*

they reproduce not only separate sounds but the general sound of continuous conversation. "They develop an amusing conversation-like jargon in which they jabber for hours at a time."[1]

When the child reaches the stage in which meaning is attached to any selected sound, the influence of training and adult speech begins to operate, and when the mother plays with the baby and talks to him of "tick-tock," teaching him to wave bye-bye, etc., speech progress is usually more rapid than where children are neglected. The general experience of war-time residential nursery workers was that children in some of these institutions were far slower in learning to speak than were children in their own homes. Dorothy Burlingham and Anna Freud state "When children are home on visits, for instance at Christmas or during their mother's holidays, they sometimes gain in speech in one or two weeks what they would have taken three months to gain in the nursery. Similarly there are many examples of children brought up at home who lose their newly-acquired ability to speak during an absence of the mother. Regression of this kind is further proof of the inter-relation between contact with the mother and learning to speak."[2] Many children who have even reached the stage of speaking a few words have been known to give up speaking for as long as a year or more, when the birth of a new baby makes a radical interference with their mother's relationship at this time. Direct efforts to "teach" the child are often fruitless, and are better abandoned in favour of special ways of giving him the needed reassurance that he is loved and of helping him to deal with his jealous feelings.[3] In *Infant Speech* Lewis points out that often

[1] Goodenough: *Developmental Psychology.* (Appleton Century Co.)

[2] *Infants Without Families.*

[3] *Fears and Jealousies,* by Ruth Thomas. (National Association for Mental Welfare, price 6d.)

the three processes, expression, imitation and training, combine to link a sound with a definite situation, and that when this stage is reached the child's advance is rapid.

The first half of the second year sees a real assault upon language. Out of the baby's repertoire of expressive sounds and imitative noises there emerges a vocabulary, intelligible at least to those nearest the child. He attaches sounds to familiar people and objects and is stimulated to linguistic invention by the lively interest he takes in his surroundings. Words frequently take an onomatopoeic form: moo-moo; bow-wow; quack-quack. Any list of first words contains repetitive words such as din-din; ta-ta. One hopes the story of the baby whose third word was "atmospheric" is apocryphal! It frequently happens, however, that intelligent children who are able to understand spoken language are very late in learning to talk, and when they begin they do so by using not isolated words but whole sentences. It is often not realized how much a child understands of adult speech long before he can use it himself. Parents frequently feel helpless with children who are unusually slow at speaking, and make less use of spoken communication than they might do with advantage. This further retards the child's growth not only in speech but in his sense of being an independent person. It usually means that the mother does many things for the child which he would quite understand doing for himself if talked to about them. This independence would naturally further his wish to talk and so speed up progress in all directions.

Though the child has by now linked sounds with definite situations, it is doubtful if at this stage the word stands apart from the general situation. The single word used can be considered as a sentence, "milk," for instance, may mean "I want some milk," "chair," "lift me

into my chair." The object named is not separated from desire or feeling and the child uses the word to express a totality. Lewis notes the tendency to deal with a situation as a whole rather than an object within it and points out that throughout a child's development, language is so closely related to his activity that his first conventional words may well have a wider application than they have among adults.

The Appearance of Sentences

According to Karl Bühler this form of speech can appear as early as fourteen months or as late as three and a half years. The next great advance, usually made between one and a half and two comes with the discovery that everything has a name. He believes that this discovery has for the intellectual life the importance that learning to walk has in the physical sphere. Now that he knows everything has a name, the child can manipulate things in his mind. "That? that?" he asks, in the earliest stages by means of an inquiring grunt, pointing to one thing after another, and as a result of his eagerness he increases his vocabulary very rapidly. One-word sentences are left behind and several words are combined into complete and sometimes complex sentences in the child's desire to make statements. Words are not always put together in the order used later. A negative is often expressed after an affirmative. "B . . . wants dinner no." "My doll, not touch." Sometimes composed sentences are made by juxtaposition: "Look dolly bed . . . put doll bed." There is also a taste for antithesis. "Boo" (the cat) "got tail. Babba got no tail." Ideas are probably more manageable set out in this way. By this age the child has passed the simple stage of recognizing familiar objects and pictures. He can now talk about the things he sees, interpreting the picture and even drawing conclusions from it. Charlotte Bühler gives

an example of this: " Baba laughing, Mama laughing, all laughing."

Vocabulary at one year and nine months to two and a half, consists chiefly of nouns and verbs though other parts of speech are beginning to be used. It is always difficult to classify a child's language into parts of speech. Words should be classified according to their meaning to a child not to the adult and as has been pointed out one word can mean either an entire situation or a request. With the young child speech activity is about as incessant as activity of trunk and limb, but, as H. Johnson has shown,[1] language as a tool for communication is not wholly developed, and gesture, largely full body gesture, is freely used. Towards two, however, gestures are giving place to words and vocabulary increases noticeably. Authorities differ considerably as to the size of vocabulary at any given age. Methods of selecting children and of testing them are varied, yet it would seem that ability to use 250–300 words is characteristic of the two-year-old. There are many, however, whose vocabulary is nowhere near 300. Especially is this true of institutional children, whose lives are so often passed in a narrowly-confined sphere in which experience is limited, and in the case of the children of illiterate persons or those who have been neglected. There are others whose vocabulary very much exceeds this number. These belong as a rule to cultured homes where they have been talked to and played with in a thought and language-promoting way. However, as Gesell points out, the length of a child's sentence and his ability to sustain intelligent conversation are more significant than the number of words used. Children, like adults, usually understand a great many more words than they use. There is as a rule a dearth of prepositions and conjunctions and an increasing ability to use these correctly is one

[1] H. Johnson: *School Begins at Two.* (The New Republic, N.Y.)

of the characteristics of the progress in language that a child makes between three and five.

Nursery School Age

By the age of two when the child enters the nursery school, he should have acquired a useful vocabulary and a knowledge of uninflected speech. He should then be able to speak of and interpret absent things and begin to use the language of thinking as shown by the words "because, if, when." Children do not always arrive so well equipped, and many of them pronounce such words as they know so badly that it is extremely difficult for the teacher to understand what the child is trying to tell her. This adds very much to his unhappiness and is sometimes the cause of temper tantrums from sheer exasperation. It is characteristic of the speech of most two-year-olds to mutilate words. Vowel sounds appear to be easier to grasp than consonants which are often eluded, either the initial consonant or last syllable is dropped, such as 'ittle for little, tow for towel. Then only the stressed syllable remains. This difficulty in pronouncing consonants rights itself fairly quickly as the child grows, especially if he hears words clearly and well spoken. Speech retardation may of course be due to various causes. As has been already suggested, children who are talked to and played with and those whose emotional and social developments are satisfactory tend, as a rule, to speak earlier and more freely than those who have been neglected. On the other hand spoiling in the form of too much attention and anticipating the child's needs by saving him from the necessity of asking, remove the incentive and delay the acquisition of speech. Emotional dependence which arouses the desire to remain a baby and thus keep the mother's attention, is also sometimes responsible. Ill health that retards all growth and

deafness or partial deafness can also delay or prevent speech development.

The fuller social life that the child experiences in the nursery school has an excellent effect on language development. Language is primarily a social instrument and the presence of other children as well as adults stirs the child to talk about the many things he sees and is enjoying. A great deal of talk is in monologue form. Children sit side by side, each carrying on a monologue, each stimulated by the presence of the other though neither listening to, nor responding to, the other. There is a tendency to repeat sentences for emphasis: "My daddy's going to give me a dolly—my daddy's going to give me a big, big dolly. My daddy's going to give me a dolly as big as this." In the same way children will sustain contact with adults by a long stream of conversation to which they do not require an answer, though they expect attention!

The more varied experiences in the nursery school and the many thought-promoting occupations are also conducive to the mastery of words and the acquisition of ideas. "In this, each of the two factors aids the other, the advance of ideas pushing the child to new use of sounds and the growing facility in word formation reacting powerfully on the ideas, giving them definiteness of outline and fixity of structure."[1] There are many ways in which the nursery school teacher can help the child to acquire good speech and an adequate vocabulary. She can encourage him to talk freely and widen his experience so that he will have ever more and more things to talk about and will thus acquire the necessary new words. She can let him hear his mother tongue beautifully expressed, by carefulness in her own speech—especially in tone of voice and use of words. Yet to speak slowly and distinctly are not in themselves enough. The

[1] Stern *Op. cit.*

words should include some that are unknown to the child and understandable by their context, and the voice should be full of colour and life. Children are very quick to notice artificiality and are depressed by dull monotony of tone or over simplification of speech. Unusual pronunciation or strange words amuse them; they repeat the words with much enjoyment—and profit! On one occasion a young student with a very Scottish accent heard a Cockney child call her friend Gricey. She said "We don't call Gracey—Gricey." "No," answered the four-year-old without hesitation, "And we don't call her Greasey neither." They soon begin to find amusement in nonsensical words, in making them up and in repeating and elaborating newly-heard words. This play with words, or more correctly play with sounds is characteristic of the child's sense of humour. He is amused by the unusual, the ridiculous, the unexpected—people falling over, an object turned upside down, a word pronounced differently. When he wants to be amusing he makes faces, falls about, twists his limbs—"making faces with my body" as a child aptly described it. His enjoyment in repeating and chanting words that strike him as "funny" and in inventing amusing names for things and people is far removed from that delight in using words either in a way that implies a double meaning or with the precision that constitutes wit. As Pope describes it:

> "True wit is nature to advantage dress'd
> What oft was thought but ne'er so well expressed."

Wit is an intellectual achievement possible only when the individual has acquired a rich store of words so clearly mastered that they can be used as jewels to catch and reflect the light of the mind. The teacher who with a quick and nimble mind, a sense of humour and skill in the turning of a phrase helps the child to build a vocabulary

of clearly understood words can aid his intellectual development possibly more than by any other service she can render.

Building a Vocabulary

Dr. Montessori has pointed the way to vocabulary building in the precise words and phrases she requires to be used in presenting her material to children. For instance, instead of the words "big" and "little" used indiscriminately to differentiate objects of different proportions, words that clearly describe the difference must be used. Large and small or big and little for objects in which there is a reduction in three dimensions. Long and short for those with a decrease in one dimension, etc. Similarly the exact names are given to all the various colours and geometric forms employed. Children experience no more difficulty in learning these terms and phrases than in acquiring the names of the thirty or forty children they meet daily in the school. Every new experience can be accompanied by new words to express it. The teacher does not need to talk much, and to say a little and say it well is probably sounder psychologically than to half drown the child in a sea of words, as so many teachers do. Words do not mean anything to a child until they are associated with actual experience. To learn the use of suitable words therefore is an essential part of instruction at this age. All the various tools and utensils used by the children can be spoken of correctly and also the flowers in vases, the plants in the garden. Stories can be told and rhymes repeated till children nearly know them by heart and are able to join in using words that are normally outside the scope of daily conversation. Two to four years of age is the sensitive period for language development during which children are receptive to teaching and quick to imitate and repeat all they hear. It is a time that should be utilized fully,

for it is as difficult to compensate at a later period as it is to eliminate bad pronunciation and faulty phrasing. The nursery school provides a unique opportunity for the development of good speech for its own sake and as a spur to intelligence and sociability.

During the nursery period children make considerable progress in the use of pronouns. Ballard gives the introduction of them as I (which is used as a rule between 24th and 27th month though frequently earlier) you, myself, him, her, my, you, he, she. Children may then be expected to acquire the inflection of verbs, a knowledge of plurals, comparison of adjectives and adverbs. Karl Bühler notes that " the chief inflection of words all appear at almost the same time, a proof that they are probably due to the same mental advance." The language progress which a child makes from 3–5 years of age is typified by "ability to use prepositions appropriately, by his employment of descriptive words, his tendency to deal with larger units of thought, and his ability to bring clauses and sentences into logical relation both in imagination and practical narration."[1] In grammar the child tends to be more logical than the language itself, " she's " for " hers "—quoted by Sully—is reasonable and so is the general weak conjugation of verbs, though possibly by some survival of the genius of the language a child occasionally coins a fine new form. Sully quotes " scram " for screamed and " splat " for split. Most teachers and parents will be able to recall the original and vigorous way the child lays hold of language and subdues it to his use. If a child does not understand a word he converts it to an understandable one—" Our Father who art in heaven, Harold be thy name "—being a well known and frequently heard interpretation. " The child's phraseology is the real arena of his independent activity. If he wants to express a thought-form for which he can

[1] Gesell : *Mental Growth of the Pre-School Child.*

find in the stock of phrases he has acquired no fitting expression, he comes to his own help in his own way."[1] Hilda Stern called sheep and lambs "Mama baas and Hilda baas": a small boy not knowing the word kennel, spoke of a "dog's garage."[2] Another made reference to a fierce dog as like a "lion-bear." Yet another spoke of rain as pattering. "We must remind ourselves . . . that when a gifted child with full heart and pent-up mind makes use of such everyday words as flower, bird, home, mother, longing; hate, afraid, magic, dark, time, and so forth, they may be symbols to him of sensations or thoughts or feelings from the intensity of which life and habit may for us have taken off the edge. Scores of early memories have given proof enough of this. Harriet Martineau's prismatic colours, Frank Kendon's succory flowers, Mr. Forrest Reid's dream, Thomas Hardy's first love and the sunset colours on the staircase, Leigh Hunt's porpoises. The mere words for such experiences are poverty stricken to convey the state of mind and imagination that may have been not merely of the earthly moment but related to the experience of the mystic."[3]

With the knowledge gained from handling things, the child between two and four soon learns to use words expressive of space relationship. It is easy to demonstrate above, below, inside, near, underneath, etc. Time relationship presents greater difficulties and few three-year-olds use words like yesterday and to-morrow correctly. The words merely connote some time that is not now. "Are we going to the country holiday yesterday?" "No, not yesterday, next month." "Will that be Christmas?" "To-morrow," "next month," "Christmas," and "when I'm a big girl" are all much of a muchness and not clearly distinguished from yesterday.

[1] Stern: *Op. cit.*

[2] Board of Education Report on the *Teaching of English*. (H.M. Stationery Office.)

[3] W. de la Mare: *Early One Morning*. (Faber and Faber.)

The confusion is perhaps understandable. The concept of time is so abstract and puzzles even mature minds. Moreover for little children life is so vivid, memory so clear, and imagination so lively that they find it difficult to differentiate the present from past experience or to comprehend a future. When they are promised something in the future they are helped if it is related to known experience, such as "when you have been to bed for two nights it will be the party day."

Verbal Reasoning

Practical reasoning is very much ahead of the ability to do so in words and in his play the child shows that he is reasoning, judging and drawing conclusions long before he does so verbally. Towards four he begins to ask and to give reasons; to think things out and discuss them logically. When he habitually reasons verbally it represents a very big advance. This is usually followed by a spate of "why" and later of "how" questions. Sometimes these are causal questions, and at this more developed stage explanation as well as information is sought. Piaget in *Language and Thought of the Child*, gives a very illuminating classification of "why questions" and the many possible answers. All questions are not easily answered. One, quoted by Sully, asked by a small American girl after contemplating her small sister was: "Why ain't Edna Belle me, and why ain't I Edna Belle?" The search for causes which grows out of curiosity in general is, as Piaget says, one of the most subtle forms of intellectual interest, and carries the child on to a really scientific frame of mind. "Why" becomes "How." "How do babies come?" is a very general question towards the end of the fourth year. Sometimes the form of the question shows that the child has already gone some way in the arrangement of facts. "About lions," asked a boy of four and a half, "Do they grow

like a plant, are they born like a baby, or did someone sit on an egg?"

Interest in stories grows towards five years of age. This is probably all part of the same movement of the mind, and an expression of the desire for an extension of the child's world to things beyond his immediate environment—a step in the journey towards abstract thought.

Though experiments, tests and observations of the development of speech have been extensively carried out, especially during the first two years of life, a great deal more research on the subject is needed. The nursery school is an ideal place for this. The children are free and spontaneous; they remain in school for many hours a day, including meal and bed time, at which children talk as freely they would at home. As there are middle-class nursery schools as well as those for the poorer class comparative studies could also be carried out. It is to be hoped that future nursery school teachers will be able to pursue investigations in different aspects of development of which speech is an important one because of its bearing upon intellectual growth and social adjustment. But even if such research is not always possible, every teacher can do much to ensure that the child "says what he means and means what he says." Though language goes on developing throughout life, by the age of five at latest, children should have mastered the form of speech, have a vocabulary of about 2,000 words, and be capable of understanding adults and of expressing themselves easily and well.

CHAPTER VII

PROGRESS IN EMOTIONAL STABILITY

THERE is no aspect of early education more important than the cultivation of emotional harmony, essential as it is to both mental and physical health. It is not too much to say that the individual's usefulness as a member of society, his happiness and general efficiency are dependent upon it.

Men and women who remain emotionally immature are colourless in character and lack the driving force which enthusiasm provides. They are seldom fully aware of or able to make contact with others in a way that inspires fellowship. The power to enter acutely into the joys and sorrow of one's fellow men may carry with it the penalty of a too sensitive heart, but it does add enormously to the richness and vigour of life. On the other hand people with strong emotional impulses who either fail to control the expression of them or who repress them, are hampered instead of being enriched. Inner conflict, or the over-preponderance of any one emotion such as jealousy or fear, inevitably creates a lack of harmony in the whole personality which may render the most brilliant intellect powerless. It can also produce ill health and, according to the late Sir Farquhar Buzzard, Regius Professor of Medicine at Oxford, it frequently does so. He estimated the proportion of his patients whose ill-health was caused by some ill-regulated emotional disturbance as two-thirds. The unhappiness caused by lack of confidence, jealousy, feelings of frustration and loneliness is indeed incalculable. Often the victims of such psychological sickness seek compensation and escape into an imaginary world, wherein they play the parts they

vainly desire to fill in the real world of experience. Such people tend more and more to withdraw from normal life, hiding under masks that sometimes take the form of humility and uselessness, sometimes that of aggressive hostility. For most of these human misfits, subjective harmony seems to be definitely out of reach, even with the help of constant objective distraction. Some drift by this road into delinquency and crime, for the criminal is in many cases a person of unsatisfied desires who, feeling inadequate, tries to re-establish himself in his own estimation by outrageous deeds, feats of bravado and various unsocial acts by which he draws attention to himself. "Better to reign in Hell than serve in Heaven," said Satan in *Paradise Lost*, and there is no doubt that many an emotionally ill-balanced person prefers the notoriety of crime to a feeling of constant and humiliating inferiority.

The strong man is he whose emotional life is as vigorous as a team of lively horses and as well controlled. He has at his command driving power to take him where he wants to go, however stiff the climb, however many the obstacles. Well-controlled use of this vital source of energy is usually accompanied by good physical health and the old expression "the face of a happy heart" is truly indicative of the marriage of emotional and physical health.

It is possible and important for education in emotional stability to begin in early years when the emotional life is vigorous. It is far more necessary for the young child to form the habit of using and expressing his feelings in a balanced and appropriate way than to acquire intellectual knowledge or specific skill.

Early Stages

Emotional behaviour occurs early in babyhood and as it usually arises from physical conditions, is more general than specific in character. Young babies screw up their

faces, cry lustily, and stiffen their bodies, but it is not easy to discover whether their behaviour is the result of anger, fear, hunger or pain. At that age, the emotions are unspecialized but they soon become more specific and appear under appropriate stimulation. "Fear, disgust, anger are found at the age of six months and jealousy by the age of eighteen months. The pleasant emotions differentiate into affection at twelve months and affection divides into affection for adults and for children at eighteen months. Thereafter more emotional reactions appear. Our language is rich in words that describe emotions: awe, wonder, surprise, elation, depression, melancholy, envy, love, anxiety, trepidation are but a few."[1]

As the child approaches his second birthday emotional activity increases in frequency and intensity. The years eighteen months to four are critically important from the point of view of the emotional life and it is at this time that the child must find opportunity for the full expression of his desires and at the same time learn to co-ordinate them and to become their master. At this age when resistance, affection and desire for independence are all strong, he must learn to steer his ship, to trim his sails and keep an even keel. He needs help and guidance from those who are themselves well-balanced emotionally and who have some understanding of the problem with which the child is confronted. The teacher should make a study of emotional development and will in doing so come to a better understanding of herself as well as of her children. She will discover how many of the disciplinary problems that occur in the nursery school are the direct result, not of the child's uncontrolled behaviour, but of her own unsatisfied and uncontrolled desires. It is important for her to have a life that is

[1] K. Bridges: *Social and Emotional Development in Pre-School Children.* (Kegan Paul, Trench, Trubner and Co., Ltd.)

emotionally, as well as intellectually, satisfying outside the school, in order that she may be free from emotional pressure in her dealings with the children.

Emotional Behaviour at Two and Three

When the child, by reason of newly acquired powers of walking, begins actively to explore his environment of things and people, his experiments frequently bring him into situations that are strange and baffling. Adaptation is called for and emotional responses arise in reaction to new stimuli. The child experiences fear, curiosity, anger, pleasure and excitement. The emotions thus aroused create energy which must find an outlet. His reactions are at first very simple and primitive ; he cries, runs away, hits or laughs, etc. If the emotion aroused is agreeable, he persists and possibly tries to repeat the experience. If it is unpleasant, he withdraws and avoids similar situations unless, as a result of influence, he is induced to master the emotion and possibly change it into another and more powerful one. Timidity for instance, may be replaced by courage, fear by fortitude. The very young child is uncritical of his own behaviour and cannot judge whether it is suitable or otherwise. He is influenced entirely by whether it succeeds or fails. If, for instance, by crying and running away the child succeeds in avoiding situations he dislikes or the necessity of doing things required of him, he will judge these acts to be successful and will resort to them whenever necessity again arises. In this way many a quite unsuitable response becomes habitual. It is part of the adult responsibility to help the child to enjoy and make a success of emotional behaviour that is suitable—such as laughing at a tumble—and not to enjoy unsuitable behaviour such as crying or temper tantrums.

At this age when the child is becoming increasingly conscious of himself and his power, one of the strongest

impulses is the desire to dominate. It is by the exercise of this impulse that he becomes master of his surroundings and successfully manipulates play materials. This assertiveness is the cause of many emotional outbursts, as the child is so often thwarted and frustrated by his lack of skill. This is particularly true if the child lives exclusively in an adult setting where he finds himself unable to lift things, to reach them as he sees others doing, or is prevented from doing the many things that suggest themselves to him. His inferior size and strength keep him at a disadvantage and the feeling of frustration arouses rage and rebellion in a normal child. A feeling of inadequacy if confined to specific situations only, is of no significance. No one can succeed in everything and throughout life such feelings are aroused by incidents which are accepted naturally. It becomes a source of danger, however, if the child is constantly frustrated, if he never succeeds in mastering the things around him which keep him ever a slave and dependent.

One of the many good features of the nursery school is that the furniture, equipment and all the general arrangements are planned to enable the child to live as master of his world, capable of succeeding in most of the actions he attempts, though not always without effort. Beds are low and easy to get in and out of, so different from the usual cot and its prison-like bars. Wash basins and taps, pedestal and plugs, tables and chairs, crockery, domestic utensils, as well as doors and windows, are all of a size and construction that enable the child to use them skilfully. Thus he gains power and confidence and is freed from a feeling of inferiority.

Influence of the Social Environment

The desire for independence and domination also brings the child into frequent conflict with the human world of children and adults. This social situation

arouses many emotions, jealousy, hostility, obstinacy, temper as well also as the incentive to control them. Every individual has to learn to subdue or control himself for the common good if he is to be a happy and useful member of society. The child learns slowly but is much helped by the social life of the nursery school. At first he is very inexpert in expressing the many emotions aroused by other children. He expresses himself in actions, not words and these frequently get him into difficulties. Other children respond with an equal display of emotion and thus quarrelling often breaks out. Yet, slowly and experimentally, he succeeds in building a pattern of behaviour that is satisfying to himself and to others. The strengthening of the social impulse has a strong influence in establishing emotional control.

In his attitude to adults the young child is often obstinate, for resistance to adult authority is at its height at about two and a half to three years of age. Such behaviour should be regarded as normal and right at this age. It is the expression of a wholesome impulse to develop will power and strength of character and to establish himself upon his two feet psychologically as firmly as he has just succeeded in doing physically. It is only by trial and error in his dealings with adults—or one might say more truly trial and success—that he can learn where conformity with adult wishes is inevitable and in which directions he can be free and independent.

The Mother and Child Relationship

When the child passes from the amenable baby into the stage of obstinacy during which steps taken to protect him from harm are the cause of many emotional outbursts, this change is the cause of some concern to the mother if it is a first baby, and if she has not had the opportunity of studying the course of child development. Many a mother is troubled at this change. Some resort to

slapping and scolding, others show that they are deeply moved and make such comments as " Mother doesn't love you any more, you are too naughty," or " I am going to find another nice child instead of you." Such attitudes makes matters very difficult for the child whose behaviour is the direct result of forces and urges within him that are often greater than his power of control. He becomes a sort of battleground of conflicting forces, the urge to be independent and self-reliant, warring with the deep love he feels and craves, that tempts him to continue clinging and dependent. Mother love means protection and the child needs to feel sure of this. He is himself more loving at about two than previously and for this reason also does not want any separation from his mother. When conflicts occur between them because he is difficult and rebellious, this conduct invariably raises a barrier that arouses anxiety and fear in the child lest he thereby lose the love that means so much to him. This is, in fact, the first serious crisis the individual has to face in life, and one that is far reaching in its consequences. Subconsciously, the choice has to be made between becoming independent, cutting himself off from his mother with the risk of losing her, or to count the " world well lost for love," and remain docile and dependent. Either course carried to extremes must lead to difficulties later in life. The fear of loving and of yielding to love lest it become possessive has spoiled many a life. On the other hand a persistence of emotional dependence arrests growth at an infantile stage and leads later to a constant demand for sympathy and the inability to stand alone or make capable decisions, unless supported by expressions of approval.

The situation is rendered still more difficult for the child if another child is born in the family during this struggle for emancipation, especially if until then he has been the only child. If he has not been prepared for this

event or made interested and eager for a baby brother or sister, in his jealousy he sometimes tries sub-consciously to be a baby again and so hold the attention and love of the mother as once he did. Bed wetting, being "difficult" about food and needing to be fed, adopting babyish talk or ceasing to talk, developing pains and illness that arouse care and anxiety in adults, are but some of the devices resorted to by the unhappy, lonely child.

Where the mother is understanding and unfailing in showing her love; when she recognizes that the bursts of obstinacy and rebelliousness are no more "naughty" than the cutting of teeth and rejoices in this evidence of healthy psychological growth, few of these anxieties or the behaviour to which they give rise occur and the child passes through the time of emotional upheaval strengthened and ready for the next step in life. The mother-child relationship is so close a bond that anything that disturbs it may cause serious consequences later in life. But it should not become over-emphasized or prolonged and the child should be encouraged and helped to become emotionally independent.

Release through Fantasy Play

It is significant that while the child is passing through this stage, fantasy play occupies a considerable proportion of his time. Play of this kind provides a useful outlet for emotion, helps the child to find security and to face more readily the demands made upon him. He lives over his experiences and dramatizes himself in many situations of the wish variety. He spanks the doll and scolds the teddy bear which affords great relief to him if he is feeling jealous or angry. It is also a means of getting rid of a feeling of guilt that rises so readily, if the child feels that he has displeased his mother, or fallen below his own standard of behaviour on which he has very definite feelings. By externalizing his hopes and fears in an

imaginary experience he gains power to face real situations. "One of the most helpful ways of studying the nature and relative strength of a child's own drives is by watching how he treats his dolls or playmates with whom he identifies himself. He treats them as he is accustomed to be treated and has them do what he wants to do. In the same way the role he selects to act is expressive of his own drives and ambitions, even if it is merely to squirm along the ground like an alligator. . . . Again observation of the way children behave with regard to those they dislike gives further clues to their own drives and behaviour-conflicts. Any person, and even the rag doll may be treated with favour or disfavour at different times dependent on real events which have encouraged, checked or handicapped the child. He may identifiy himself in his actions with the constraining authority and scold or impede the other self-surrogate. Or he may emulate the behaviour of the object of his affectionate attachment in flattering pantomime. Here we see among children at so early an age the origin of the social scapegoat or hero."[1]

Play material that gives opportunity for getting rid of emotional tension is necessary, such as hammer toys, target games and plastic material that can be taken to pieces without being destroyed, also dolls and models of animals and human figures. Material with which messes can be made is also desirable, for all this kind of play supplies an outlet for aggression that prevents its being used anti-socially.

During the period of emotional intensity, when the child is eagerly loving and demanding love, it is important for him to be cared for by and to associate with people who give and encourage an ample expression of love. This is necessary not only to give emotional satisfaction and so lay the foundation of mental and physical health,

[1] K. Bridges : *Primary Drives in Infancy*. Child Development, March, 1936.

but also to cultivate the soil in which the seeds of the spiritual life can germinate. From the complete dependence of babyhood, if the child is wisely guided, warmly loved, encouraged and protected, he should develop ever increasing self-confidence and self-reliance, without which he can never become emotionally poised or fully adult.

The Contribution of the Nursery School

During the years in which such impulses are stirring and violent, life in a nursery school or class is extremely helpful to the child. In association with other children and with different adults the child's feelings are diffused over a larger number, instead of being focused on one or two people as is usual in his home. Thus they become less intense and less personal. In the nursery school the child tends to react to the situation as a whole rather than to the teacher as a person ; and gradually begins to get a true perspective of his relationship to other children and to adults.

" In the majority of cases the child's response to adults outside the home and to other children in the nursery school are never quite so intense or so ambivalent as to the actual parent or brother and sister at home. It is indeed a not uncommon experience to find the contrast quite marked. There are many children who are much easier to manage by any adult other than the mother and it is an interesting psychological question as to why this should be so. The skill and experience of the nursery school teacher must of course count a great deal, but this cannot be the whole factor, and by no means are all Nursery School teachers wiser than the children's mothers."[1]

It may be that the explanation lies in the fact that the

[1] Susan Isaacs : *The Nursery Years*. (George Routledge and Sons, Ltd.)

child meets the Nursery School teacher on a different footing. As he has never been dependent upon her as upon his mother he has not to fight against his own habitual attitude, nor hers, nor against any strong emotional tie between them. The teacher also is more detached and, unlike the mother, has time to wait for the child and his slow fumbling ways and to adjust herself to the " timelessness " of children as Wagoner calls it, for she has only one occupation—the care of the child. It is possible for her to be calm and unhurried as well as dispassionate.

Though naturally less attached to his teacher than to his parents, the child gives his love very generously to the adults in the nursery school and expects love from them, especially from his own teacher, and in this he must not be disappointed but must be sure of her response. Affection springs up between children too. They hold hands, sit close together, play near to one another and give many indications of liking one another. Some children are very demonstrative and want to kiss and carry one another about. They also want to sit close to the teacher, if possible in her lap and invite her caresses. The teacher must respond affectionately and not be afraid to show the tender feelings she has for each child, but she should help them to recognise that there are other and more desirable ways of showing affection than handling. Though she should occasionally pick up and comfort a lonely two-year-old, it is on the whole better for her to discourage physical contact either between children and herself or between one child and another. In the latter case she should explain that children do not like to be nursed or carried when they are getting big.

Tender emotions can be fostered by the keeping of pets, especially those that have young chickens, rabbits, guinea-pigs, etc. Children's love and tenderness are very real when caring for them. Reverence and awe, or

perhaps more truly, the seed from which they emerge will be set, if nature-work is skilfully treated.

Educating Emotional Behaviour

It must be realized that though emotions arise spontaneously, the child is quite inexperienced either in controlling these feelings or in expressing them in a way that is personally and socially acceptable. Education consists not in suppressing or eliminating but in helping the child to acquire suitable forms of behaviour for all situations. He has to be helped to increase and to vary the ways in which he reacts to impulses and situations and to make habitual such as are most suitable and appropriate. His responses are at first few. They frequently take the form of crying and running away in cases of fear and when angry kicking, stamping, pushing and hitting or throwing himself down. None of their reactions are suitable either in themselves or as the starting point of character formation. The child has to discover and adopt better ways of giving vent to his feelings. Crying is a common form of behaviour and with some children tears come readily. If the child cries because he falls down it does not necessarily mean that he has hurt himself. He may be merely annoyed—or humiliated by his own want of skill. He may cry if another child has a toy that he wants. In each situation the teacher has to help him to find a better way of reaction and one suitable to the occasion and so build up a variety of responses. She can suggest laughing at a fall, or seeing how quickly he can get up, unless the child has hurt himself or had a bad shock when he needs comforting. The cultured person is one whose reaction to any situation is always appropriate. This is indeed the secret of gracious living, for the uncultured have but few reactions which are used for many and varied occasions, a limitation as unpleasing as the habit—common to so many people, of using the same verbal

responses—" You don't say ! " " What I mean to say ! " etc.

Briefly skill in training lies in helping each child to find and adopt whatever behaviour gives him personal satisfaction and at the same time fits him to live with others. Behaviour cannot be standardized and each child must be helped to adopt the way that is suited to his age and temperament. Whenever possible, situations that arouse hostility, defiance and negative emotions generally, should be avoided. They weaken the child's confidence and dissipate energy that might be used constructively. Discipline should consist, not so much in imposing restrictions, as in providing outlets and in directing the flow of vital energy into channels that make for growth. In other words it means giving children the opportunity to do what they want to do, provided it is not harmful to himself or others.

Though the child must be given freedom and opportunity for the expression of his desires, it would be both impracticable and unsatisfactory to expect him never to conform to adult wishes when they are inconvenient to him. There must inevitably be certain matters in which the child is expected to do as the adult wishes and to control and subordinate his own desires in order to do so. These should not be too numerous, but they should exist. Children feel happier and safer when assured of a background of adult guidance, and are strengthened by the conviction that someone is looking after them who is stronger than they and who will not let them do what they know they should not do.

Problems of Discipline

There are of course occasions on which, however tactfully the child is approached, he resists with violence, possibly with anger and refuses to do what is required of him. So long as temper is in the ascendant it is

inadvisable for the teacher to attempt anything, for discipline must never become a battle between the child and the teacher and cause a state of tension. She would be wise to withdraw temporarily giving the child time to recover and then to make a fresh approach, treating the situation impersonally and in a matter-of-fact manner, explaining that " everybody does it in the nursery "—or that " it is time to do it now "—and she must persist as long as is necessary to win the child to conform. He must realize that circumstances do not change, whatever his behaviour. If by tears or temper tantrums he succeeds in changing circumstances—if, for example, bedtime is postponed, or hand-washing abandoned, he will in all probability adopt the same behaviour on the next occasion. Unsatisfactory behaviour must never be permitted to become successful or enjoyable. Tantrums are often but an unconscious means of getting rid of aggressive feeling and should not be taken too seriously.

Adults have acquired a great many ways of avoiding doing what they do not wish to do. The child has but one reaction—" 'won't ! " " Don't want ! " The teacher who is really understanding will help the child in his difficulty, by suggesting ways that will bring mediate if not immediate results. She can say for instance—" Will you be ready to come when the clock strikes " or " When you have finished that "—or " It will be dinner time very soon, are you getting ready ? " Working with the child in some such manner usually prevents conflicts and shows courtesy and consideration for him. To demand immediate obedience is neither just nor reasonable and in asking for it the teacher is more often intent on gaining emotional satisfaction herself than on training a child. Children dislike interruption when they are keenly interested in some project, just as heartily as adults do and " While stubbornness may be anti-social, persistence and willingness to carry on in spite of disappointments and

opposition, are of value to society, particularly if for a worthy cause. Anger is in itself neither good or bad. What makes it good or bad are the circumstances under which it appears and the after effect on behaviour."[1]

Sometimes children behave badly in order to focus attention on themselves, and when successful they tend to make a habit of such behaviour. The best way to deal with this is for the adult to turn a blind eye and a deaf ear to this sort of conduct and to manifest interest in the child when he is behaving well.

Overcoming Fear

One of the strongest emotions the child has to learn to face and control is the emotion of fear which every child experiences in some form or another and for which he should build up adequate responses. Fear is quite normal; it is a defence mechanism without which man could not have survived. The more intelligent a child is the more vivid are all his emotions and "intelligent children experience fear much more acutely than dull ones. . . They see so much, think so much and appreciate so much; and all the influences that flood on the mind are so acute that they suffer for being intelligent in this way. . . One of the definitions of the feeble-minded child is that he does not appreciate danger and fear as he should . . . he will expose himself to danger without realizing that he is in danger . . . he is not brave—just stupid."[2]

Children are chiefly afraid of unexpected occurrences. Sudden noises, such as thunder and lightning, alarm them and so do things that make them feel at a loss or insecure, strange places and people, darkness, quickly moving objects. Quarrelling among adults and especially between parents is also very frightening to the child because

[1] J. Anderson: *Happy Childhood*. (D. Appleton Century Co.)
[2] W. Moodie: *Children Fears*—pamphlet issued by the London Child Guidance Clinic.

of the feeling of insecurity it gives, and it is this insecure feeling that causes babies to cry when held by those whose grip is loose or fidgety. All children do not experience the same fears, nor do all of them occur in early years. Little children are much more frightened by loud or unexpected noises, and by anger among adults than older ones and whereas most young children delight in squeezing themselves into small spaces, many adolescents are afraid of such close confinement. "Fear waxes and alters with growth. It is shaped by intrinsic maturation as well as by experience, certainly during the period of infancy . . . the (fear) pattern we would suggest is as much the product of organic growth as the various stages in the elaboration and perfection of prehension."[1]

Building up Morale

During nursery days the child can be helped in many ways to face his fears and to build up *morale*. The cause of the particular fear can be investigated, and the mother or teacher can adopt a calm attitude herself. Sometimes she can turn the alarming occurrence into a game and get the child to join in too, but it is generally better not to discuss the fear lest it help to fix this and hinder his effort to adjust himself.

In no case should children be required to do things of which they are really afraid. It would be both cruel and harmful. Facing fears means gaining courage to overcome them. If for example it is the see-saw that frightens the child, time spent in watching other children might help—or sitting by the child the teacher can make a song about it—"Here we go up, up, up, and down, down, down." Or if another child is teasing or gesticulating she can rob the incident of its terror by laughing and proposing to chase and catch the offender. Action is

[1] A. Gesell: *The Individual in Infancy* from Foundations of Experimental Psychology. Ed. Murchison.

usually more effective than words. If the fear is inspired by a dog—and big dogs are often terrifying to small children—the teacher can show its harmlessness by patting it and letting the child talk to it and feed it. On the other hand, a situation may arise when a child has to be taught caution in patting strange dogs and above all in crossing public roads. This must be achieved without arousing fear. Learning caution in this increasingly dangerous world should be inculcated by a training in alert awareness and self reliance, and it should be exempt from emotional significance.

In the presence of fear the teacher should always aim at breaking the tension by some action. Wherever the situation can be made the means of laughter, this should be done. Laughter cures most ills and robs fears of their terrors, but needless to say it must be laughter with a child at the thing that frightens him, and never laughter at the child himself or his fear. Above all she must encourage a frightened child to face its fear and not to run away from it. Fears faced usually become fears conquered.

" Fear and fortitude are opponents, but both are necessary for the growth of character. To omit fear altogether from a child's life, were that possible, would be like omitting vitamins or salt from diet. If fear and fortitude are developed hand in hand, the child will become resistent and sympathetic. Indeed the elements of character are so paradoxical that full development of fortitude depends on experiencing and overcoming fear. Wholesome fear generates its own mental antibodies. It is a kind of vaccination."[1] Dr. Crichton Miller is also illuminating on this subject. " Fear," he once said, " is on one side bondage and on the other side dis-ease. It is bondage because it distorts a child's adaptation to natural experience or his social relationships or both." It also

[1] Gesell: *Mental Growth of the Pre-School Child.*

"begets compensatory aggression and an aggressive child is neither co-operative nor contributive. . . . It prompts withdrawal from reality and hinders the child from making his adjustments to circumstances and environment. Real health means that the child should be at peace within himself and not constantly impelled to escape with some objective activity or distraction."

If helped wisely and in as matter-of-fact a way as possible, to face fear and adopt suitable responses, not only will the child acquire morale and fortitude and the essential qualities of real courage, but may also develop a "philosophical sense of humour which can be set down as one of the essentials of mental health. This sense of humour will serve him well as a child, it will serve him more as an adult."[1]

It is not only unusual or unexpected things that cause fear. Children may become suddenly afraid of things that they have experienced so frequently that it is not easy to understand the appearance of this new attitude. One who has enjoyed his bath for instance, and played merrily while taking it, may suddenly develop a terror of it or of going to the lavatory. Is it the rushing of water and the gurgling sound it makes as it rushes through the plug-hole, and if so, why should this suddenly frighten the child who has witnessed the occurrence so frequently without concern? Night terrors may occur soon after two. They occupy a considerable part of the child's fantasies and daydreams and are probably the cause of many fears. Others again may arise as a result of conscience that is born in these years, which often makes the child more severe with himself that adults would be, and very distressed when he falls below his standard. Such sudden fears are not as a rule long lived, but are very real and, should they persist expert advice should be sought. The "much managed" child who has angry

[1] Gesell: *Guidance and Mental Growth in Infant and Child.*

outbursts sometimes becomes afraid of his aggression.

The anxiety to which these inner feelings give rise is more difficult to recognize than fear of tangible objects. It is as a rule disguised in behaviour that is misleading to any but a trained person. Being excessively good is often as symptomatic as aggression or lethargy. It is not possible for the teacher to trace unusual behaviour to its source, unless she is a trained psychologist, nor is it necessary. Children have the power of releasing and curing these feelings for themselves in their play. For this purpose they need free play with water, dough, sand, paint and paper and material or objects that can be taken apart and manipulated. The teacher must be ready to recognize symptoms of fear and anxiety and see that the materials by means of which it can be played away are available. She must also give the child abundant evidence that he is loved for himself, believed in and protected by one who is strong and dependable.

The adult can give the child confidence in himself and in his power of winning through if she treats his lapses lightly. If commenting on them at all she should assure him that everybody has accidents and makes mistakes and add " I don't expect it will happen again." When he realizes that the adult believes in him and his good intentions, that she is there to help him to grow strong, anxiety will decrease and he will gradually feel strong enough to conquer any fear.

In helping a child to be brave he should never be encouraged to deny his fear, for this is in a sense a kind of running away from the situation that sets up all kinds of conflicts within the child. To persist in the face of fear may sometimes be dangerous but makes for the strengthening of character. " The brave man is he who recognizes and accepts natural fear due to his instinct of self-preservation, but who persists in spite of his fear. The anxious neurotic mistakes fear for cowardice. Thus

arises the conflict between his instinct and his ego ideal that no man should be a coward. He solves the conflict by suppressing or repressing his fear, and developing some nervous illness which gets him out of his difficulty. . . . The child must learn to accept the situation as it really is, and not as he would like it to be. To quote Hadfield —Know thyself, accept thyself, and be thyself. A child can learn all this, and in addition take pride and pleasure in an individual victory over individual difficulties. He can gain courage and confidence and power to go on in spite of it."[1]

THE PLACE OF LAUGHTER

Laughter is one of the most successful and the best ways of relieving emotional stress and children who are naturally happy are as ready to laugh as to cry. Learning to laugh and using it as a satisfactory " mode of behaviour " in any kind of emergency should be a definite form of training at this period of life. Children laugh readily at queer sounding words and delight to invent them, burlesque toys—especially mechanical toys, men and animals turning somersaults. They also laugh as a relief from strain—a door that bangs suddenly and noisily or a gust of wind that carries off a tablecloth may cause a moment of surprised silence—occasionally accompanied by fear. Then if the teacher laughs they all laugh and find release in doing so. No one can be healthty and normal who does not laugh often and merrily and no day should pass in the nursery school unaccompanied by the happy sound of children's laughter. " One of the pleasantest things that ever happens—that babbling infectious expression of good spirits and satisfaction with living is one of the rewards of living and working with children."[2]

[1] Howden : *Child Upbringing and the New Psychology*. (Oxford University Press.)

[2] L. Wagoner : *Development of Learning in Young Children*.

If there is an atmosphere of goodwill and joy in the nursery and if the teacher is herself full of quiet content that makes for smiles as well as for ready laughter, this spirit will spread like joyous contagion and will become the key-note of all that happens.

CHAPTER VIII

SOCIAL ADJUSTMENT

THE first years of a child's life are spent in the discovery of his world and in adjusting himself to the people and things which constitute it. The way in which development is brought about by the individual's power of adapting himself to his environment has been discussed in previous chapters. In exploring, experimenting and adjusting himself to his material world, the child has a much simpler task than that which confronts him when learning to fit in with people. " Things " are fixed and unchanging. The child can investigate them unemotionally and once he has mastered their main characteristics, can use them as he wills without resistance on their part. His attitude towards them is primarily intellectual, and such emotions as enter into it are the result of his success or failure to achieve victory over them. His degree of adjustment is determined by the extent of his intelligence and skill.

The world of people presents a different and much more complex problem, partly by reason of the different attitude that he brings to its solution and partly by the varied and constantly changing nature of human beings. The child is himself a " complex of countless conditioned reflexes, associated memories, habits and attitudes, which are acquired as a result of his being reared by personal beings."[1]

At the same time he possesses an inner life of his own in which impulses and emotions arise spontaneously and incessantly, seeking outlet and satisfaction in association with people. The human beings with whom he desires

[1] Gesell: *Guidance and Mental Growth in Infant and Child.*

contact, whom he wants to love and sometimes to dominate, are, unlike things, very different from one another and constantly changing. They are actuated by feelings and influences that the child cannot understand or control. He has to face the dual task of learning how to approach people in ways that give him emotional satisfaction and that are, at the same time, socially acceptable. Intelligence and the capacity to learn from experience play a large part in this adjustment but are not all-sufficient. The process involves an organization of the personality as a whole: an organization which must include emotional harmony, control of will, and an ideal of behaviour. Thus in becoming socially adjusted the child forms the pattern of his personality and prepares himself for the complex art of living as a civilized human being. This is therefore a very important aspect of early education. "Personality which seems at first glance to refer only to the individual is seen upon analysis to be a social term. Not only is the child fast or slow, good or bad, trustworthy or faithless, honest or dishonest, a leader or follower in comparison with others, but he also builds these very traits out of his relation with others."[1]

Social Behaviour in Infancy

The child's social life begins as soon as he is born and definite social behaviour appears early in babyhood. In the space of a few weeks the baby responds to people in a way that is quite different from his reaction to things. By the end of the first month, or soon after he smiles when his mother or nurse speaks to him, and the smile is a "definite social reaction" says Charlotte Bühler, who points out that the child's attitude is positive from the beginning. As he grows he becomes increasingly interested in the adults who attend to him, following them with his eyes, chuckling when they come near.

[1] J. Anderson: *Op. cit.*

Whether they smile or frown, his responsiveness is always positive—smiling and cooing and generally indicating contentment. After about six months he begins to differentiate frowns from smiles, to react negatively to frowns by withdrawing, or crying.

This positive attitude towards life, which the philosopher interprets as indicative of the true nature of man, though it must inevitably undergo trials and storms as the child grows, can be preserved or rudely shattered by the treatment the child experiences at the hands of those on whom he is dependent for food and protection. Social training begins in these days of babyhood influenced by the way his mother deals with him. Her serenity and love can do much to fortify the trust he places in her so completely—an attitude that is later transferred to other adults if it remains unshaken. The child who through the first two or three years of life finds consistency, friendliness and dependability in adults, will be likely to grow up expectant of finding all people kind and loving and because he expects this, he will induce it in those with whom he is brought into contact. Man usually finds in life what he looks for. On the other hand, the child who is mis-handled, whose faith in people is shaken by misunderstanding or an untimely display of emotion or moods, goes forth to life less adventurously. He is apt to be apprehensive in attitude, never very sure of himself nor of the reception he will get. When this is so he frequently becomes shy, withdrawn and does not develop fully.

Until a child is six or seven months old he takes little or no interest in another baby. After that age his interest is as a rule lively. He smiles, tries to touch his little neighbour, offers toys or snatches them and endeavours in various ways to attract his attention. "Before the end of the first year of life practically all forms of social behaviour seen later in life can be observed in embryonic

form. There is domination of one child by another, leadership, involving bullying and submission. There is imitation, co-operation, generosity and selfishness. There is the dog-in-the-manger child who snatches at the other babies' toys, but makes little attempt to play with them. There is the over-generous child who proffers all that he has to others."[1]

Social development during the first year is very much helped when the mother takes time to play with her little one, to talk and sing to him during bathing and dressing and at other times. The child shows his desire for contact with adults in many ways. Sometimes he throws his toys out of his pram for them to pick up, chatters and calls when left. When he begins to walk and talk, the admiration and attention he receives to protect him from harm are very satisfying to him and he runs the danger of becoming the centre round which the household turns. This is in fact an important period of life for character training. The way he is praised or punished, and the extent to which he is allowed to take the centre of the stage may have a determining effect on character. Children must pass through what has been described by Hadfield as the "Eastern potentate" stage, but care should be taken that they are not arrested there. This may result if a child is prevented from living out this phase completely, when a tendency to revert later is created, or by over-indulgence that may lead to an unhealthy prolonging of it after the child should be seeking emotional and social independence. There is many a mother who, unable to bear the thought of losing her baby, prolongs this stage of dependence.

The Two-Year-Old Child in the Nursery School

By two years of age when the child enters the nursery

[1] F. Goodenough: *Developmental Psychology*.

school, his newly acquired powers of walking and talking should have had a very stimulating effect on social development. During the next few years this is rapid, helped by the genial family life of the nursery school. Often the child on entry is still absorbed in learning to talk, and he uses this new power to establish and hold contact with both adults and children. He chatters unceasingly and though much of it is in the form of monologue, he likes an audience. "You sit here and watch me," he sometimes commands taking the adult by the hand and leading her to a chair. He brings his toys near and chatters about what he is doing. He does not require nor expect an answer, but he does expect attention. "You are watching?" he may ask at intervals. Long strings of questions flow forth, but neither to these is any answer required. If the adult replies to a question by saying "You tell me," the child will be quite happy to do so provided he believes her to be as interested in the answer as in the question. When first he enters the nursery school he is still, as a rule, more interested in and more responsive to adults than to the other children, which is understandable, for he has already considerable experience of adults and has, generally speaking, learned to trust and depend on them. To him other children are still an unknown quantity. This is specially true in the case of an only or first child when he is inclined to regard them with curiosity, sometimes mixed with fear, and often as rivals for the attention of the adult that he wants to keep for himself. The two-year-old is moreover usually too preoccupied with his own pursuits to take much notice of his little neighbours whom he is inclined to regard rather as things than as people though he may suddenly demonstrate a desire to fondle or kiss them.

There is no aspect of nursery school organization in which wisdom and care are more needful than the provision for these two-year-old children. Their first

adventure into a wider life than they have previously experienced exerts a powerful influence on social behaviour during nursery school days and on social development generally. These young children should be in small groups, six or eight at most for the first few weeks, and under the care of a knowledgeable and loving teacher with whom they will feel secure and well " mothered." The transition from the intimacy of home life to the nursery school, especially if the school is a large one, can be a very alarming experience and unless it is well guarded the child may receive a shock that is definitely harmful. The presence of an older brother or sister or neighbour in the small group, who can take charge of the newcomer at meals or sleep time often eases the situation.

If these first few weeks in which the child forms his attitude towards people outside his home circle are happy, he goes onwards to wider contacts fearlessly and with joyful expectation, so that by the end of his nursery days he is buoyant and sociable, ready for the friendship forming stage that lies ahead. If on the contrary the beginning is an unhappy one, either because the child feels lost or lonely, or because he is frightened by the numbers and the boisterous behaviour of big children of five, future contacts are less readily sought and are likely to rest on a less secure footing. Many a timid two-year-old who may also be distressed by the crying of others of his own age has to " go through it " where numbers are too large for the teacher to give the individual care and attention necessary. Insecure on his feet he may easily be pushed over, his toys snatched by domineering children and loss of bladder control resulting from nervousness and other emotional causes, may add to his misery. Such an unhappy beginning, almost inevitable when there are many in the group, may have two consequences. It may hinder the spirit of social adventure and create a tendency to solitary play and release in fantasy, or it may

lead to a desire to take it out of some other child more timid than himself. A feeling of inferiority frequently leads to bullying and even to brutality in later years. Unless he is adequately protected, the formerly timid baby often becomes a tease and a bully, and so a vicious circle is established that undermines the beneficial effects that should result from nursery school life. When, from the first moment, children are made to feel welcome, happy and protected, as happens in most nursery schools, the child adopts this friendly attitude towards the other children and by four or five years of age habitually assumes the role of big brother or sister to the younger ones, delighting in caring for them. When the four-year-olds are rough and quarrelsome, the reason can usually be traced to their experience in the reception group.

The Way of Development

The desire for friendly contact with other children grows rapidly during the ensuing years. The tentative gestures—smiling and proffering toys, soon lead to watching and following one another around. One often sees them walking about hand in hand both talking, though not necessarily listening to the other. Their approaches are frequently experimental, becoming skilful only as a result of experience. This clumsiness is met on their own terms, and children have a way of settling things between them that is natural and entirely suited to their level of development. Adults are often in too great a hurry to make children friendly and co-operative, but sociability, like all learning, must wait upon maturation. If children are left free to make their own advances to one another in their own way, the result is always more satisfactory than when they are persuaded by adults to play together. The plan, in operation at some schools, of letting the big ones choose little ones for their special

Timothy at 20 months explores alone

Two-year-olds enjoy helping others but sometimes resist being helped

Progress in sociability: from solitary play and tussles to co-operation

care, looking after them at meals, bedtime and taking them for rides in wagons, etc., provided this is not overdone, helps very much in the creation of friendliness. Two-year-olds will often play more freely with four-year-olds than with the other two-year-olds. This makes the four-year-olds feel very grown up and responsible which awakens protectiveness and love as they care for the little ones. This intercourse should take place occasionally during the day for those who desire it but too much of it is not good for either. The four-year-olds have their own interests into which the younger ones cannot enter and their development is hampered if they are denied the kind of play needed for their special needs. If, in addition, they are of the managing type, too much opportunity to look after others might over-develop this tendency. The younger child also needs time to himself in which to become self-reliant and often these little ones show no special desire to be mothered. Many of them are very independent and it is instructive to see how the older children will adapt themselves to their vagaries remarking, "He is only a little one—he doesn't know yet."

Individual Differences

Children vary very much in the speed with which they settle down into the ways of nursery schools. Some feel at home from the earliest moment, entering into everything wholeheartedly and enjoying everyone that comes their way. Such children have the qualities of "good mixers." There are others who are in trouble from the first day. Sometimes these are aggressive or "spoilt" children who snatch and bully and are the cause of quarrelling and unsocial behaviour generally, arousing hostility wherever they go. Often, however, it is the timid frightened child who arouses hostility and bad behaviour. His own fearful attitude, his ready tears, the

ease with which he can be pushed over and his inability to stand up for himself, seem to awake in others a perverse desire to tease. A mother's darling or a boy with long curls and girlish clothes often becomes the butt of others who persecute him in much the same way as chickens peck at a sickly member of the hen-coop.

Charlotte Bühler groups children into three main types: the socially blind, socially independent and socially dependent. "The socially blind infant behaves in the presence of another child as if nobody were present. He looks at the other child without emotion, takes his toys, plays, moves, without regard for him, not interested in him at all. The socially dependent child is deeply impressed by the other child's presence and activity. He can be either inhibited or stimulated by it. In the first case he will not move, will watch the child and copy him, and give signs of fear before him. In the second case he will display in front of the other child, will demonstrate objects and gestures and will try to arouse the other's attention. He observes the effect of his behaviour on the other and carefully watches the other's reaction. The socially independent child is he who, though aware of the other's presence and responsive to his behaviour, yet does not seem to depend on him and is neither intimidated nor inspired. He reacts to the other child, warns him off if necessary, but never behaves aggressively himself. He may, or may not, join the other in play, though sometimes he even consoles the other, encouraging him and taking part in his activities. Yet with all these he remains independent in his movements."[1]

These three types are familiar to all nursery teachers but anyone who has watched the remarkable social

[1] Ch. Bühler: *Social Behaviour of the Child* in Handbook of Child Psychology. Edit. Carl Murchison. (Clark Uni. Press also Oxford University Press.)

development that takes place in children when the Nursery School is wisely conducted, is tempted to ask whether these types are fixed and final. Are they the result of constitutional factors, or, can they not be more truly described as due to potentialities that have either been inherited or partially developed through early experience and susceptible of being modified by education? On the whole a child who is socially dependent if given opportunities to strengthen his self-dependence and awaken real objective interests usually ceases to insist upon an audience. The child who is socially blind from whatever cause when given a daily chance to help, as in serving meals, carrying trays, sweeping, dusting, arranging flowers, bed making and generally helping to get things ready for others, becomes aware of other children and their needs and at least partially conscious even if he never becomes socially full-sighted. Much research is needed before it can be said that the person, who in childhood appears socially blind is destined to go through life self-absorbed and permanently insensitive to the feelings of others, or that those who in their earliest days are socially dependent cannot learn to become unattached.

A Spirit of Experiment

At the beginning of their nursery school days children approach one another in the same spirit of experiment that they use in investigating things. They have yet to learn customary procedure and whereas adults use speech to ask for or to refuse things, children resort to action. They just take or try to take what they want with the result that they are frequently slapped, pushed and screamed at by the child approached. In such cases behaviour is as a rule free from serious hostility or unfriendliness and seldom arouses either. It is often amazing to the adult who so quickly becomes resentful, to note how a child whose toys have been snatched or who has been pushed will sit

beside the aggressor and continue to play quite unmoved. There are of course frequent incidents that reveal hostility and jealousy, but such outbursts are short-lived. A quick flare-up, pushing, hitting, a few tears and all is at peace again. In these early years children often need direct and explicit teaching as is given when they are taught how to dress or undress, to ladle soup, etc. They need to be told " It is better to do this " —or " I think Joan will let you see it if you ask her " or " That is Peter's waggon. He had it first. You can have it when he has finished with it " —or "you can find another in the cupboard."

The cupboards of two to three-year-old children should contain replicas of favourite toys as at that age children have not learned to wait turns, while the desire for possession is keen and leads to much quarrelling. Criticism or scolding should in such cases be absent. The teacher must relate behaviour to stage of growth, and where help is needed, she should give it by direct teaching and never be fault-finding. It is only through careful showing many times repeated, and through constant experience that children acquire suitable behaviour. Gradually they learn to respect the rights of others, to refrain from spoiling others' play and to fit in with a group. There are many changes of social behaviour between two and five years of age as children " progress from socially indifferent infants through the stage of self-assertion and interference with the liberties of others to a period in which they show consideration, sympathy and kindness for others. When that is reached they delight in group play, and co-operate with one another for mutual enjoyment. They then show real concern for the approval or disapproval of others and express their own appreciation or the contrary in words rather than in actions."[1]

[1] K. Bridges: *Op. cit.*

A good deal of experimental hostility, much of which arises from social interest, is evident at three or thereabouts. At that age children want to discover what others will do under different circumstances and how much power they can exercise over them. Experimental hair-pulling, punching, pushing, is indulged in, not with a feeling of unfriendliness, so much as with real curiosity or sometimes in a spirit of fun. Snatching of toys and running away with them, knocking over another child's building, occur frequently then, and are usually done with one eye on the reaction produced. The desire, in many cases, is to establish contact, not to arouse aggression. It is the teacher's task to help the child thus approached to appreciate the spirit of the other child's action and also to help the experimenter to discover ways of approach that are more socially acceptable. Children vary very much in their reactions to such behaviour. Some of them turn the incident into a game, proceed to chase the offender, with laughter and good-humoured puppy-like wrestling that both enjoy. Some children on the other hand become aggressive when interfered with and hit back, either by attacking the offender or his property. Others give way to violent temper tantrums and seek on such occasions adult protection tearfully.

The teacher must always be on the watch to keep these approaches good-humoured and to encourage the children to see the fun of it all. Laughter is very infectious and a good solvent. The more real fun children have and the more spontaneous their laughter, the more rapid will be their social development, for there is always a tendency to repeat what is enjoyed.

On the whole children quickly learn to settle their own differences and in doing so make more rapid and satisfactory progress in social adjustment than when the responsibility is taken from them by adult intervention. The following incident is an illustration of this. Three-

year-old Jean was adopted at about two and a half by a very devoted, middle-aged couple, after spending her early life in an institution. She was extremely anti-social towards all other children whom she appeared to regard as natural enemies. When she first entered a nursery school, if another child watched her at play, or stood near her table, it was enough to arouse her wrath. She would scream and push him away. One day when Jean was experimenting with a tricycle, Mary, a very good-humoured and sociable little girl of about the same age, watched for a time and then said, " I'll pull you ! " and seized the handle-bars. In an instant Jean, leaning forward, gave Mary so violent a push that she was knocked down. This was to Mary quite a new experience and one that so amused and surprised her that she burst into merry laughter as she rose and went again to the tricycle, saying, " Do it again ! " Jean did, a little more tentatively, but Mary threw herself down, kicking up her heels and laughing merrily. Again and again she reappeared, " Again ! " Jean appeared very mystified. Her punches grew less violent—Mary " fell down " more boisterously until both children were laughing heartily. The teacher did not witness this incident—and could hardly believe her eyes when on looking she saw Mary with a skipping-rope over the handle-bars, pulling Jean along—both of them laughing and playing together. Mary's unfailing good-humour, and Jean's own laughter and fun had broken the ice for her. Gradually she learned to play with other children and outgrew her aggressive habits in the pleasure she found with them.

It is the teacher's responsibility to make and maintain a feeling of goodwill and friendliness in the little community and while leaving the children free for their experiments, to prevent aggressive behaviour from being harmful either to the aggressor or his victim. Success in any kind of behaviour even if it comes by chance

will lead to its repetition, and the child who acquires the habit of leading may become a leader in time. On the other hand the child who derives pleasure from anti-social behaviour will continue to be anti-social. In late years much delinquency is due to the satisfaction it gives the child to be anti-social—to dodge police and outwit adults.

John, a very timid two-year-old, had spent the first week at a nursery school clinging to his teacher. He would neither play with other children nor with toys. At the beginning of the second week, though still firmly attached to his teacher, he began to watch other children and on one occasion walked up to a three-to-four-year-old called Peggy who was playing with a doll and stood watching her. Peggy took no notice of him. Suddenly he pulled the brightly coloured bow from her hair. Peggy began to cry. John looked surprised and watched with interest until she ceased crying and began to play again, still taking no notice of John. Thereupon he took a firm grip of Peggy's hair and pulled it. Peggy yelled and John who had been tearful himself and always solemn began to laugh heartily. He stood near Peggy laughing until she ceased crying—then pulled again and laughed again at her tears. Afterwards he approached another little girl, pulling her hair and was very amused at her yells. A third was treated similarly. None of the three-year-olds made an attempt at self-defence, they just yelled as though they were puppets set in motion and John walked from one to another pulling hair and laughing merrily. It was his first approach to other children and there appeared to be neither hostility nor unfriendliness in his action. It was an inexpert invitation to play that was not successful. But his first social experiment had proved amusing and there is no doubt it would be repeated should opportunity occur. Had any of the children attacked John or defended themselves the result would have been very different.

The other side of this incident must not, however, be lost sight of. Though John's intentions were apparently not unsocial, should he continue to approach children in this way and find pleasure in their tears, he might begin to enjoy and to practice anti-social behaviour especially if it gave him a keener sense of power. The incident was typical of egocentric behaviour often seen in young children, so well described by Dr. Isaacs when she said " The essence of the egocentric attitude is that it involves a recognition of the presence of other children but not of their personalities or independent purposes. The one child needs and uses the other for his own satisfaction. . . . In the beginning it is implicitly assumed that the other will accept the role assigned."[1]

LEARNING TO PLAY TOGETHER.

One of the reasons for the popularity of the nursery school is the fact that it gives children an opportunity to associate with others of the same age where there is a leeway for the individual to withdraw from the group and carry on schemes of play without interruption. " We find that quite intensive social play like hauling each other in wagons seems to reach a point of spontaneous disruption. Without coming to a climax it subsides and is usually followed by a period of quiet during which each child is employed at some individual activity such as play in sand, or block building, etc. Throughout the nursery school age this characteristic remains typical of the children. It is one that should be encouraged since it protects them from the strain of sustaining too long periods of accommodating to the demands of social contact."[2]

As a step towards group play children have periods

[1] Susan Isaacs : *Social Development in Young Children.* (G. Routledge and Sons, Ltd.)

[2] K. Bridges : *Op. cit.*

of what has been called parallel play. Two or three of them will choose the same play material, tools, blocks or dough and collect together. They appear to be playing together but in reality each is pursuing his own game regardless of the other. They are influenced and stimulated by one another's proximity, there is frequent imitation of one another, but it is in no sense group play. These early experiences of playing near each other are limited and occasional, but because children enjoy this "togetherness," such play provides the soil out of which co-operative play springs.

As children discover the value of one another as companions and playmates, the habit of playing together is established and groups of three and four are formed. Children join together in a game or in making things and thus begin to subordinate their own desires to those of others. An element of give and take appears. They learn to await their turn, to share, to lead and follow, to assert or accept as the group needs. There is usually a group leader and the teacher must see that all have an opportunity for leadership and to develop both passive and active qualities. A balanced character is one in which what is called maleness and femaleness are equally developed. Social play can do much towards character development if all children have an opportunity to lead as well as to follow, to dominate and to submit.

Social and emotional development are closely interrelated. The child's social world awakens in him love and tenderness for others and a desire to be loved. It also arouses jealousy and hostility as well as the incentive for the control of these emotions. The child, eager to play with others finds that tears are less effective than smiles; that temper tantrums bring no helpful solution; that it is more successful to wait for a thing than to snatch it. Friendships are formed—groups of three or four may play together perhaps for many days or only

occasionally. Large groups are seldom formed and children do not begin to work and play as a team until eight or nine years of age. For this reason collective games are few and short in the nursery school. They are introduced chiefly with the intention of providing children with a rest from planning and being responsible for themselves and as a form of relaxation and amusement. It is doubtful if they contribute greatly to social development, but if they are really good fun, they induce a desire to play together.

Attitude towards Adults

During nursery years the child undergoes a change in his attitude towards adults as marked though quite different from the change in his attitude towards children. In the latter case he progresses from indifference towards friendliness and by the end of the nursery school years he has developed a liking for co-operative play and begins to form real friendships. With the adult the process is reversed. At two years of age the child is very attached to and dependent on his teacher. From this clinging dependence he passes through a phase of resistance to adults and their requests eventually reaching an attitude of general friendliness of the somewhat non-attached kind. He delights to assume the position of the teacher's right-hand and comes to regard her rather as a colleague. As his capacity for friendship with children strengthens, he depends less and less on the teacher. A change of teacher at four or five matters much less than at two when it seems like the loss of real support and security. Though the four-year-old child is less dependent on the teacher—or perhaps because of it—he will ask for and accept help from her in a way that he rarely does at three. In doing so he shows that he has acquired an attitude towards authority that is both sound and healthy. Though a child's chief concern is to acquire

skill in his social behaviour with other children, it is important for him to form an attitude towards adults that will make him neither a slave nor a rebel. The easy friendliness that exists between children and teachers in the nursery school is very satisfactory. It is what Wagoner calls " a two-way process out of which develops a mutual respect and appreciation."[1]

The teacher must, by the atmosphere she creates and the general arrangements she introduces, devote herself to the task of making sociable and not unsociable acts enjoyable. Every child must be made to feel that he has a place, is loved and expected to be helpful to all. The teacher's own behaviour towards every child and towards her own colleagues can do much by unfailing courtesy, and gentleness, to create an atmosphere that awakens this behaviour in children. She can also help by joining in the children's play and giving it a turn that brings in other children or that gives it a social direction. The right suggestions at opportune moments which call out playful response, and are given with psychological insight, can often turn potential aggression into protection and encourage timid children to make sociable approaches to one another.

[1] Lovisa Wagoner: *Observation of Young Children.* (McGraw Hill Publishing Co.).

CHAPTER IX

RELIGION IN EARLY CHILDHOOD

A STUDY of the history of mankind from the primitive state to civilization reveals one characteristic common to man at every stage of his evolution—the impulse to worship. The religious spirit, which finds expression in many forms, is as definitely part of human nature as the upright position, hands and speech. Thus in a normally growing child the impulse arises inevitably, and, if the environment is favourable, grows into religious conviction and a spiritual outlook on life.

THE CHILD'S ATTITUDE

During the pre-school years, qualities and attitudes that are the soil in which the religious impulse grows, appear naturally. Whether or not they develop into the fullness of religious faith depends on the adults with whom the child is associated in his impressionable years. It depends upon their response to the child, the attitude towards life that they reveal, and the nature of the experiences they make possible for him. The characteristics that arise so naturally are fourfold. There is love of these adults, and faith in them, and the implicit belief that they will give both love and protection. The child has a positive attitude towards life and towards his elders; he lives by admiration, hope and love, never expecting anything but good to come to him. There is also a growing awareness of himself which brings with it the birth of conscience; a compelling impulse to discover the how and why of things, and the feeling of awe and wonder. These are characteristic of every normal child. It is the duty of parents and teachers to strengthen and develop these potentialities so that they may ripen into

spiritual faith, a sense of ethical values, a desire for truth and the capacity for worship.

Adults can help children's religious development in two ways. The most important way, particularly in early childhood, is by the example of their own lives and characters. It is this that creates the first, deepest and most lasting impression, not only because it comes while the child is in an impressionable period of its life, but also because as a rule it is given unconsciously. One cannot analyse the power of an unselfish character, but "there can be no doubt about its reality, and there seems to be no limit to its range."[1] The other way is by explicit teaching. This comes after pre-school days, though a limited amount of teaching can be given to children even in their earliest years.

Indirect Training

The basis of religious training is laid in babyhood and is inspired by the character of the mother on whom the child is dependent and from whom he gets his first impressions. She is the bountiful giver of all, it is to her that he looks for love, for protection, and it is for her that he feels his first love, trust and belief. The way in which the mother tends the infant, gives him the breast and later weans him from it, her handling of him as she bathes and changes him, all affect the child emotionally, either giving him a sense of happiness and peace, of safety and security, or causing fear, unhappiness and distrust.

Later, when the child begins to walk and acquires a degree of independence, he becomes aware of himself as a person, capable of defiance or acceptance of others. He then reaches a stage in which his need of the assurance of love and understanding is great, for the independent outlook is based on a confident attitude towards life and trust

[1] Paget: *The Hallowing of Work.*

in the reliability of people and things. If his adult world fails him, if people are despotic or insincere, the basis of the child's religious outlook is weakened. He becomes negative in his attitude, fearful, and defensive rather than trustful. It is doubtful if a child who has never felt safe or secure, nor known the peace that protective love brings, can ever develop that implicit love of God and trust in His never-failing care and guidance that are fundamental to religious belief.

It is moveover important for him to realize that love is a protective armour that gives strength and courage but never restricts or hampers and that he must give love, if he would have it. " For the little child in a good home the Kingdom comes (as it does for us) in mutual love. It comes in experience of beauty, and the wordless thanksgiving for happiness."[1]

The teacher's attitude must reveal at every moment of the day her trust in him. She should make it clear to him on the many occasions when his behaviour is unsatisfactory that it is his conduct and not himself of which she disapproves, and that she expects him soon to be able to do better because she knows him to be animated by helpful motives. By avoiding personal criticism and giving instead direct teaching of more suitable behaviour, the teacher will help the child to desire good standards and be confident of his power to achieve them. If the teacher has made a study of growth, she will understand that much conduct that is unsatisfactory from an adult point of view is so, either because of the child's lack of experience, or because of the strength of emotions which he has not learnt to control. Her task is to help him to acquire better modes of behaviour and to give opportunity for expression of deep impulses, recognizing that the fount from which they spring is intrinsically good.

[1] Helen Wodehouse: *The Scripture Lesson in the Elementary School.* (S.C.M. Press, Ltd.)

The impulses are natural, it is only the way in which they are expressed that is unsatisfactory. If in addition she is always just and fair in her dealings, if she always keeps her promises and is strictly truthful in her statements, the impression the child gets of adult conduct will help him in forming his own conduct and strengthen the foundations of religious belief.

" He will get a conception of goodness because you are good to him and to other people . . . of truth because you are unfailingly truthful, of kindliness of speech because your words and your tones are never harsh ; of constancy because you always keep your promise, of consideration for others and unselfishness because he sees these things in you. You cannot speak to him of these abstract virtues, but when he can understand the meaning of these words, he will already know that he has understood them all the time, and that you are only giving him the dress of words to living things he has already learned. Long before you can talk to him of God in such a way as he can understand your words—if indeed we ourselves know or can know anything more of Him than the fringe of Himself—he will understand something of God because of you."[1]

All understanding must rest upon a basis of experience and as has already been shown in earlier chapters it is useless to try to develop an intellectual conception of anything before the child has lived with the reality of it. For example, he must have long experience of handling and experimenting with quantities, proportions, sizes, shapes, and relationships before he is ready to translate this practical knowledge into abstract calculations of arithmetic or mathematics. He must be fluent of speech and capable of expressing himself adequately before he studies grammar. So also he must live and experience

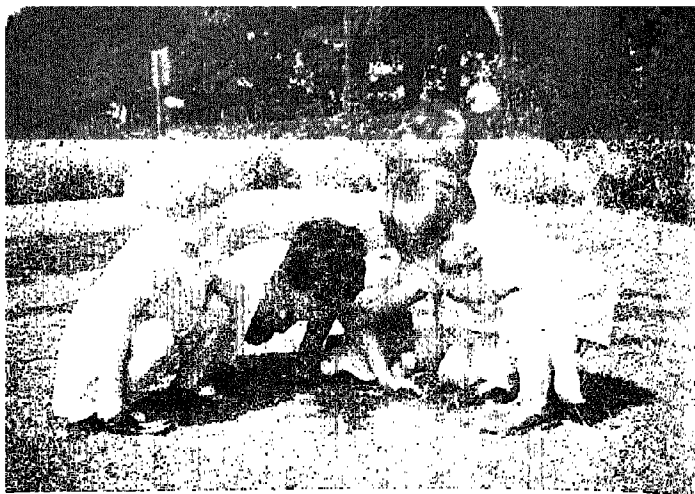
[1] H. W. Fox : *The Child's Approach to Religion.* (Williams and Norgate Ltd.)

goodness, truth, courage, patience, gentleness, courtesy, unselfishness, faith, trust and love, before he can ever associate them with the spiritual source from which they come or understand them as virtues. It is much the same road that is travelled in acquiring speech and the meaning of words. Gradually the child understands the use of words that interpret experience. For example, colour means in the first instance blue colour or green colour associated with some familiar toy, shape means round shape or square shape, also associated with familiar objects. With experience, and as the child sees these qualities in different relationships, he becomes able to think of and to use the words colour and shape as abstract qualities, not necessarily associated with any particular object. So, too, with experience, "to the spirit of love, courage, faithfulness, truth, beauty, or to the Author and Giver of all these, we teach him the name of God."[1]

The Teacher's Outlook

The first act of the teacher of young children, who desires, as every teacher must, to help a child's religious development, should be concerned with her own character. Dean Inge has said that religion is caught not taught, and it is a well-accepted fact that the teacher influences children more by what she is than by what she says. She must first discover her own convictions, deepen her own experience and become a genuine seeker after truth. Any religious teaching, whether direct or indirect, is inevitably bound up with the teacher's own philosophy of life, and it is important for every teacher and student to think profoundly about the mystery and wonder of existence. She should endeavour to realize something of the stupendous universe of which she is so small a part and the evidences of Mind, Purpose

[1] H. Wodehouse: *Op. cit.*

Wonder is the beginning of worship

" Look at our worm ! "

Enjoying the lavender

and Love that are revealed abundantly to those whose spiritual eyes are opened.

Religious teaching is by far the most delicate and subtle work that the teacher is called upon to do. It cannot any more than any other aspect of education be imparted by the light of nature alone. It makes demands upon intelligence as well as upon devotion. The teacher should study deeply and read widely philosophical and religious literature. She should know the Bible well, for it is in itself a library of wisdom, full of beauty, poetry and drama. There are few things that arouse the impulse to worship more quickly than the gospels and some of the psalms.

The teacher should spare some time every day for devotional reading and thinking which are as necessary to keep her spirit alive, as daily food is for maintaining physical existence. All real thinking should be done alone, and in silence. It involves not only intellectual activity but the spiritual exercises of meditation and contemplation. To achieve this the whole being must be tuned in to the Voice of the Spirit and the attitude become one of listening and waiting. There is so much to be done every day that is practical and useful in the busy routine of the school, that it is necessary at intervals to see all these practical, useful things in their true perspective, to lay aside the business of Martha and to become Mary for a time. Only thus will everything be recognized at its true value and be neither exaggerated nor underestimated. "The teacher must possess the habit of looking up and beyond the frontiers of the useful and obvious, and finding beyond the frontiers a beloved Reality which gives significance to the useful and the obvious. To be able to do this is to possess the spirit of worship without which no one can educate in the true sense."[1]

[1] Evelyn Underhill: *Education and the Spirit of Worship.* Winifred Mercier Memorial Lecture at Whitelands College, 1937.

Religious education is not one aspect of education. It is rather an attitude and a spirit that pervades and irradiates everything that takes place during the day. As Dr. L. P. Jacks once said "Unless it is present in all we teach it is not effectively present in anything we teach."[1]

The teacher who habitually looks "beyond the frontier of the useful" to Spiritual Reality will understand the deep springs from which the impulse rises that prompts the child's "how, why and if" play, and she will be better able to help him in his investigations than one who takes a shorter view. Although the child's immediate objective in play is the solution of present problems—such as how his bricks can be made to balance, or why he cannot make his rubber ball float like a balloon —the impulse that prompts this play arises from the same spring that sends the adult towards philosophy and religion. The child is a seeker after truth and reveals this in his play and his questions. Granted right experience, which it is the teacher's duty to bring within his reach, every truth discovered becomes the starting point of a fresh quest, until Truth itself becomes detached from particular situations and is seen as holding "wrapped within itself a whole philosophy which unfolds gradually and never comes to an end."

DIRECT TRAINING

Fundamental as is the unconscious influence of the teacher's character there is much that she must do consciously if the seeds sown by unconscious influence are to fructify. The aim of religious teaching has been well expressed by K. Penzer[2] by quoting the answer given in

[1] L. P. Jacks—Lecture on Religious Education given at Conference on New Ideals in Education, 1927.

[2] K. Penzer: *The Scripture Lesson in the Elementary School and Kindergarten.* (S.C.M. Press.)

the shorter Scottish Catechism to the question " What is the chief end of man ? " The answer is " To glorify God and enjoy Him for ever." " There can hardly be a more lovely aim " (of scripture teaching) she writes, " than this most wonderful answer."

There are many ways in which the child can be helped " to enjoy God," and while it is true that all experiences must meet the child's immediate needs and understanding, it is also important to remember that if the child is to learn to adapt the religion of childhood to the demands of adolescence and adult life (and to enjoy God for ever) his childhood's religion must have two essentials. In the first place there should be nothing in it that is fixed and final ; secondly, it must contain nothing that has to be unlearned. It must be of a kind that widens and deepens as the child grows and develops, otherwise it will soon be outgrown and discarded. Spiritual growth cannot be hurried. Every incident, gesture and word that helps to set the child thinking and feeling in a way that makes for God-consciousness becomes permanently a part of his character. The teacher must not, however, look for results or expect to see the fruits of her teaching while the child is still in the stage of infancy. She is concerned only with the seed-time, not with the harvest, and if she tries to get " results " from her religious training she will defeat her whole aim. " What you are aiming at is to produce a character saturated and not merely tinged or colourwashed with the right idea of God, and all that is bound to take time. Do not force religious growth. You are planting acorns, not mushroom spawn."[1]

Through Nature Study

The most natural way to help a child to enjoy God is through the world of nature. The response is immediate.

[1] H. W. Fox : *Op. cit.*

Children all love flowers, delight to tend them in the garden and to arrange them in vases. They love, too, insects, animals and birds, and the nursery school should be rich in opportunity for getting to know and care for young and tender things, ants and worms as well as butterflies and birds. There should be many kinds of pets, not kept in cages, but living as naturally as possible, so that the child may learn to regard them not as playmates for himself but as creatures living their own lives which it is his duty to protect. It is also important that the same attitude should be inculcated towards flowers which do not merely exist for the pleasure of people. From the beginning he should be taught to handle both plants and animals with respect. If the teacher's own approach is reverent it will not be necessary for her to say anything. Her way of handling them will promote a sense of the wonder and holiness of living things and will speak more eloquently than any words can do. "The world into which you introduce your pupils will be, roughly speaking, the world which you yourself apprehend. Unless you have developed in yourself the instinct for beauty, the sacredness the deep meaning of nature, you will not make anyone else feel this."[1]

No nursery school or class should be without its garden, and this should be as large and as beautiful as possible. It is part of the child's educational environment and should be planned to stimulate and to nurture aesthetic and spiritual development, to foster scientific interests as well as to provide a playground. One can scarcely exaggerate the value of spending much time in the garden during childhood and of discovering the many wonderful living things within it. There is something deeply moving about the influence of nature, the feel of the soil, scent and colour of flowers and about growth itself, impossible to describe but understood by all who

[1] Evelyn Underhill: *Op. cit.*

have experienced it. Children born and bred in city streets who never know anything more of nature than flowers in vases, are definitely poorer, though even cut flowers tenderly cared for can open the gates of Heaven. In addition to the washing of vases and refilling them with fresh water before the flowers are replaced, the watering of young plants, cleaning of the goldfishes' bowl and the aquarium, there should always be in a nursery school nature tables on which children can watch germinating seeds and growing plants. When the teacher spends time herself, daily watching and enjoying these things, the children will soon gather round to see what she is looking at. As they watch the water-boatmen skimming on the surface of the water, and the water-spider taking her bag of air below it, the teacher can, by drawing attention to the marvellous mechanism and instinctive knowledge of each creature, help the child to become aware of the protective love and foresight operative in the creation of all creatures. Children are very quick to feel awe and wonder, and the teacher must help to cultivate this, encouraging them to watch things for as long as they wish and to enjoy the things they watch. "Contemplation" said one of the earliest mystics is "loving sight" and in learning to watch "lovingly" children are also learning to worship. By their expression as well as by the questions they ask they show how much they are loving and wondering. "Is it really and truly the caterpillar that went to sleep that has turned into this lovely moth? How did it make its wings?" "How does the bulb drink all the water when it hasn't a mouth?" "Why don't tadpoles want to stay being tadpoles?" "Do the frogs wish they had their tails still?"—such questions are not easy to answer. When the teacher does not know the answer, or does not know how to give it in a way that will be comprehensible to the child, she must honestly say so. "There are so many things we

don't understand," she can reply, " but people are learning much by watching things. God wants us to love all these darling things, and if we watch them long enough and patiently enough, He helps us to see and understand, but it takes a long time and a lot of watching ! "

There are many ways in which the teacher can help to keep alive that feeling of wonder which awakens the spirit of worship, both in herself and in the children she teaches. She ought to be able to give her children something of her belief that there is a great Mind and a Creative force at work, a God whom we can love even though we cannot understand Him, and who makes not only the beauty we see around us, but gives us also the power to enjoy it. We can, and we must love and worship Him and give Him our thanks. In gratitude, in praise and in the desire to discover more and more of the mystery that lies behind life, lie the germ of religious feeling.

The phrase, " the teacher can keep alive the feeling of wonder " is used advisedly, for this emotion arises spontaneously in the child if he is surrounded by beautiful things which others revere. The teacher does not have to make a child religious, and possibly the less she actually says the better. Her task is to encourage the growth of what is rising naturally. " Heaven lies about us in our infancy " and there is no doubt that the child often sees with a clearer spiritual vision and understands with a keener sensitiveness things unattainable to the adult.

PRAYER

There are usually children in every nursery school who have been taught some form of prayer. But there are frequently a greater number to whom this is a new experience, and the question arises as to when to appoint

a prayer time and what sort of prayers to use. Should the teacher " kiss the joy as it flies," to use Blake's phrase, and have prayers when the moment seems opportune, which might occur more than once on some days and not at all on others? Should there on the other hand be a regular time to say " Thank you " every day? It would seem advisable to have both a regular time for " Thank you " and also to seize special times, provided neither is forced and that both arise as a real expression of joy or gratitude. When the children are gathered together to tell their news, as happens some time every day in most nursery schools, it seems natural that a " Thank you " should be included. The news itself always includes things for which thanks can be given—sick children have come back to school, the rain has come to water the garden, or the sun to make it grow. Perhaps somebody saw a butterfly, or there are flowers in the vases; or it may be someone has a new baby brother or new shoes. " Can we say thank you for comics?" asked one small boy. " 'Cos they make me laugh." One of the habits worth cultivating is that of a morning thanksgiving—a time for recollecting the good things that are ours and expressing gratitude for them. Those who have been brought up to do this are fully aware of the value of it and of the happiness with which it begins the day. It is important, however, that in the nursery school the period should not " lose its way in the dreary desert sands of dead habit," for that would be more likely to kill than to quicken religious feeling. It is better to omit a prayer altogether than to have it said except as an expression of feeling or without a prayerful atmosphere.

Prayers should be prepared for by conversation with the children that arouses the desire for thanksgiving. The form of words should be simple, improvised to include all the children wish to give thanks for. They should have meaning for the child and be more than the

repetition of words and phrases he does not understand or to which he can feel no response "Dear God, Thank You for Jimmy's new baby brother and Mary's shoes and the fresh flowers in the vases" is an example of what may be said. A moment of silence before beginning a prayer "just so that we can all think about God before we talk to Him" helps to create an atmosphere, but it should be brief and never forced. It does not matter if the children do not join in the prayer. They will absorb the attitude and the spirit of reverence that never fails to be apparent when this moment is skilfully handled and the teacher is sincere. One little boy returning from his first week in the nursery school taught his "Mummy" how to say her prayers. With his eyes closed and an intent expression upon his face his voice rose and fell as he chanted "Love, love, love, love. . . ." His mother came to the nursery to discover what it meant. "It didn't mean no sense," she said, "but it made me feel like it was a prayer."

Saying "Thank you" for dinner often means more if children know what they are saying thank you for. "Thank you for our meat and pudding," for "our milk," etc. and "Please God give all little boys and girls a good dinner to-day."

The Superintendent of a nursery school relates in an annual report of a picnic lunch while the children were on holiday. All were seated on the ground, the lunch was spread, and everyone was getting ready for "Thank you," when sudddenly a piercing voice exclaimed "Look, look at that little ant eating our sandwiches." There was a general scramble across the grass to see this exciting scene of an ant carrying away a crumb almost as large as itself. At last, after they had watched their fill, they were once again nearly ready for the "Thank you" when another child said, "Look at the birdie, does he want some dinner too?" A third, "I can see a moo-cow,"

and a general chorus, " Can you hear the quack-quack ducks ? " " We've got a puppy-dog at home." The teacher realized how artificial and meaningless it would be to persist in efforts to quieten the children for prayer when they were all so excited and she remembered :

He prayeth best who loveth best,
All things both great and small,
For the dear God who loveth us,
He made and loveth all.

So lunch proceeded, to the accompaniment of gay conversation concerning ants, butterflies, cows and robins, the things they like to eat and where they find them, and the teacher told how even the roots of the grass can find their food in the earth. Lunch over, prayer came spontaneously and was full of meaning to the children who said " Thank you " not only for their good dinner and their happy picnic, but also for the food provided for all God's creatures.[1]

" Thank you " can be said at the end of the day instead of at the beginning and the prayer can include an enumeration of the things children have enjoyed that day. To spend a few moments in remembering things they have enjoyed, followed by thanksgiving is to follow the natural order of prayer in which recollection is followed spontaneously by the desire to worship.

There are many suitable prayers that can be learned such as " God bless Mummy, Daddy, brothers and sisters." There should be many " God bless " and " Thank you " prayers.

STORIES

Stories should be chosen with care, and free from anything that might give an erroneous impression about God or anything that may have to be unlearned. Few

[1] Nancy Quayle : Report on Children's House Nursery School, Bow

Old Testament stories are suitable for young children. "Most of the Old Testament is unchristian, all of it is pre-Christian, and as such is not suitable as a beginning to religious knowledge. To understand and appreciate the Old Testament stories necessitates not only a knowledge of the Bible, but also the social and political life of the period they represent and something of the truth they are intended to symbolize. These matters are beyond the comprehension of the little child, who needs the simplest narrative and one that gives the truer idea of God than these stories are likely to do."[1] The New Testament with its stories about Jesus is more suitable, but even these stories need to be chosen with care. They should show the kindness and tenderness of Jesus for anyone in trouble, and His wonderful power of helping. These are the simplest to understand and they give the truest impression of Him.

The miracles are best omitted. They suggest magic, and thus give a totally false impression, and one that has to be unlearned before the true comprehension can be gained. In telling stories about Jesus and His desire to cure the sick and sorrowful the aim should be to give an impression of goodness, kindness and love, and to show the way in which these qualities in Jesus enabled Him to make people better and happier.

"There is an extraordinary infectious quality about goodness, whether we see it or hear it; it somehow stirs our ambitions to go and to do the same thing," and the child who translates all impressions so quickly into action, begins to play that he is Jesus. Children tend to identify themselves with those they love and admire, and consciously and unconsciously to weave the character of the loved one into the fabric of their own being. Stories of Jesus that show Him as kind and gentle to children always loving and helpful, provided they are vivid and

[1] H. W. Fox: *Op. cit.*

free from sentimentality, give the child an intimate picture of a very lovable person whom they want to be like.

The story of the Nativity—the shepherds following the star and the coming of the Kings—is undoubtedly the loveliest narrative ever told, and because everybody loves it the story is frequently told to young children. Nevertheless it is probably wiser not to tell it until they know and love Jesus as a man. Children's emotional attitude towards babies is very different from their feelings for a beloved adult, and one wants the children to think of Jesus as the protective adult. Fox stresses this and suggests that once they know Him thus and think of Him as a Friend, the story of the Nativity, " seems to have the same effect as finding the last piece of a difficult puzzle. The whole picture suddenly appears vivid and convincing not in so many fragments, but as a complete unity. The people of Jesus's time loved Him as a man, and probably hardly anyone knew of the circumstances of His birth."[1]

When telling Bible stories it is advisable to begin in a way that distinguishes them immediately from other stories. " Once upon a time " suggest a make-believe story. Bible stories should be different in phrasing, and wherever possible, biblical words and phrases should be introduced. They are beautiful in themselves and come to have their own association and meaning.

Teaching About God

Is it possible to give children an idea of God that is neither false nor that has to be unlearned because it becomes fixed and final and therefore quickly outgrown ? It is very important, as has already been pointed out, for children's earliest religious outlook, feelings and ideas to be of a kind that widen and deepen as the child matures, thus remaining a stable and ever increasing influence on character and behaviour, meaning every

[1] H. W. Fox.: *Op. cit.*

year more and more. Anything that has to be discarded leaves a doubt in the child's mind. Part of the difficulty that adults experience in talking of God to a child is due to their desire to make him understand. They should rather aim at inducing a feeling. It certainly is possible to understand with the heart and with the intuitive sense —so sadly neglected in education—many things that the intellect cannot grasp. Children understand a great deal intuitively that it is impossible for them to comprehend intellectually. As a child once said, "I do understand it all, Mummy, when you don't explain it." There are many people who feel this too, and who are aware that they may lose wisdom in their eagerness for knowledge.

In any case dogmatic teaching and the repeating of creeds should have no place in nursery years. Such teaching cannot be appreciated except as the expression of experience formulated into belief. The solid clay of dogma stamped too heavily around the tender young shoots of the spiritual life is more likely to kill than to strengthen it. Explicit teaching, which means the use of definitely expressed ideas can be effective only after the child knows the truth the words represent. The child must know and experience love before we can talk to him of Love; must feel trust and belief before we can win his Faith; must experience the joy of doing and giving up things for others before we can expect him to understand or even to be dimly aware of that mystic sense in which we are all children of one Father, and one Spirit. "It has been the weakness of much of the education of the past that it was too much a matter of mind and too little of experience; it put head against heart, knowledge against wisdom, theory against experience."[1] Intuitively the child accepts God whom he cannot see as one who loves and takes care of all people,

[1] Graham Howe: *Creative Education.* (Home and School Journal, December 1937.)

and who talks to them when they pause to listen. He is willing to accept the idea that He does not talk as people talk to each other but in His own way, by inspiring thoughts and feelings. Sometimes they can realize that He reminds them of Himself by a lovely colour in the sky, by flowers and trees, by a bird's song.

It is preferable to use the word God, which is soon accepted and gathers an association about it, rather than Father, for the latter word may give a wrong impression. In many homes in which children do not see much of their father, fatherhood stands for something different from the idea of God, the protector and provider of all. It is the mother who usually fills this role, who is the comforter always at hand, who loves and is loved, and whose presence means safety, security and peace. Thus if any word except God is used the child may adopt a false attitude and one that may be hampering to religious faith.

In conclusion one is persuaded that it is indirect more than direct teaching which is needed and if the teacher is herself spiritually alive, there is little doubt the child will catch a spark from her. If in nursery days the child can strengthen his spontaneous love of people and his faith in them, and the tenderness he feels for all living things ; if he can keep alive his awareness of unseen Love, protecting and guiding him, not only will he have a foundation for the religious life, but he will be equipped for living with an armour that will give him a sense of power and protection. He will also acquire an outlook on life so serene and positive that no matter what troubles it brings him, nothing, " neither death, nor life, nor angels, nor principalities, nor powers nor things present nor things to come, nor height, nor depth, nor any other creature shall be able to separate us from the love of God which is in Christ Jesus our Lord."[1]

[1] Romans VIII, v. 38-9

CHAPTER X

EDUCATION THROUGH PLAY

PLAY, the most characteristic feature of childhood is the child's natural way of developing himself in body and mind and preparing himself for the serious business of life. It is an activity that arises spontaneously and is similar in type all the world over. Stern speaks of play as originating " in a deep compulsion of human nature that almost brings it into line with the compulsory function of instinct."[1] It is true that the sequence of play interests never varies. Different types of play follow one another, reach their peak, and fade out to be replaced by the next in Nature's well-ordered succession. This sequence is closely related to general development.

Yet, though the child is to this extent under the " levelling influence of universal childhood,"[2] no two children play in exactly the same way. On the contrary every child reveals his nature and tendencies in a way that makes his play individually characteristic and self-expressive.

" To what extent do the play interests of the child to-day foreshadow what he will become to-morrow? What influence have social and emotional experiences gained in one's play as a child upon such qualities as leadership, independence of thought and action, and the ability to get on happily with one's fellows later on? To what extent are the vocational choices, the hobbies and reactions of the adult, the direct outgrowth of the play preferences of childhood? Much further investigation is

[1] Stern: *Op. cit.* [2] Stern: *Op. cit.*

needed before these questions can be answered completely, but as we follow the course of development onward, we can see how closely the play life of the individual reflects the development of his whole personality, portrays his interests, his abilities, his past experience. Had we but wisdom to read the signs, we should find in the child's play the surest index of his character."[1]

Not only is play the surest index of a child's character, it is also an indication of the normality of his development and of his mental and emotional health. Every Nursery teacher should continuously watch her children at play, and should keep some record of it. She should also make as comprehensive a study as she can of play itself, for this will enable her to interpret and evaluate her observations, and give some insight into each child and the kind of help and guidance he needs. It will help her to understand when and how to come forward and when to leave him alone. It will also guide her in her choice of the materials and playthings most helpful for each particular phase of growth.

The Purpose of Play

Play in childhood is more than mere pastime or a means of recreation. It is the serious business of life. It is in a sense part of the food and drink by which the child builds himself in all-round strength and becomes a poised personality. Provided it is real play, free and spontaneous, initiated and directed by each child himself to meet his own needs—and is not teaching disguised as play—it is the only form of education that really educates in pre-school years. It is through play that the child strengthens and develops his growing body and establishes neuro-muscular co-ordination, control and skill. It is the means by which he develops his mind and teaches himself to think and reason, to compare and contrast, to

[1] Florence Goodenough: *Developmental Psychology*.

judge and draw conclusions, to plan and imagine and to use his mind in all ways necessary for intellectual development. Again it is through play that he establishes and maintains emotional balance, because of the outlet it gives for the expression of feelings and the release from strain it affords. Play indeed enables him to develop his character by the exercise of the self-control, self-reliance, patience and persistence that he brings to his pursuits. In short it affords education of the most complete kind for body, mind, character and personality.

To deny a child space or opportunity for free play in all the varied ways necessary to development; to withhold from him toys and material that make play really satisfactory, is just as serious a deprivation to the growth of intelligence and character as lack of food and free activity are to the growing body. It causes psychic malnutrition, and renders the child ill-equipped for the adventure of life. Modern life which crowds people into cities has robbed children of all classes of their natural play, and new means must now be found for restoring it. Large houses and gardens are rapidly disappearing with the result that there is little place for the child to call his own in the modern house or flat, and none where he can play undisturbed and continue his play progressively for days at a time. He is constantly required to give up space to adult needs. Woods and meadows are available only to the country child, and trim parks even when accessible are a poor substitute. Streets are too dangerous to be the play-grounds they once were, while families, large enough to provide playmates of various ages, have practically disappeared. Natural material, too, is less accessible than it once was. Earth, sand, pebbles, seeds, shells are not easily available, nor is there room to-day to keep the odds and ends that once accumulated in lumber rooms and back-gardens and which led to such valuable play. To-day the child must

Playing mothers

Interest stimulates concentration, co-ordination and control

be content with the output of the commercial store, and many of the toys sold there have little permanent interest or real value. Finally he has to make do with toys that do not take up too much room, or that are not likely to prove too noisy for the adults in his small home.

"Our adult world owes children many apologies, but one it owes more than any other. The special apology for having intruded on their play."[1] In the report of the White House Conference, U.S.A., it is suggested that there should be a playground within a quarter of a mile of every home with a hundred square feet per child.

The campaign to provide playing fields for growing boys and girls has its counterpart here in the provision of nursery schools and classes for young children. The practice of bringing the "under fives" into Primary Schools and the provision for them of nursery classes should do much to improve the physique, intelligence and character, and enable them to benefit more fully from their subsequent schooling. But this will only happen if the essentials of childhood are included—ample space and opportunity for free movement, access to sun, light and air, good food, and opportunity for undisturbed free play with sensible and varied play material.

These classes will not provide a means of strengthening the child in body, mind and character if they merely serve to extend the length of traditional school life. Early schooling and training might easily become a new form of tyranny impoverishing and deforming growth. The child should be allowed to play freely and should not be prepared for school by "playful" lessons and thus initiated into school discipline and routine. When given opportunity to play in his own way, the child prepares himself for school and for life far more successfully than anyone else can prepare him. Though this period of life is definitely a preparation for the future—and the play

[1] Katherine Glover and Evelyn Dewer: *Children of the New Day.*

that nature stimulates at different stages assures this—play must be encouraged because of its value to the child at the moment. Childhood is not, and never has been fully appreciated for itself. It is protected and safeguarded, too often because it is a prelude to manhood and womanhood, and there are few who recognize the completeness and perfection of childhood itself. Christ saw it and proclaimed it and His words must have astonished the people of His day. Few teachers really accept His estimate or they would not be for ever trying to improve and alter what they see, but would leave the child free in his play, endeavouring themselves to become like him.

Early Stages

Fingers and toes are the first playthings, but the child soon begins to clutch at other objects and to hold them firmly in one hand or another. His choice is indiscriminate, as is also the use he makes of the things seized. He waves them in the air, hammers them on his cot, sucks them or throws them away, regardless whether the object seized be a spoon, a rattle, a watch or a tea-cup ! He is not in the least interested in the object. His interest is centred in his own activity, and anything that aids or augments it is of value to him. This early form of play is called by Karl Bühler " function play," and is in one sense the only real play an individual ever knows. It is performed for its own sake, without any aim or object beyond the enjoyments of the movement involved. When play is pursued to attain some goal, it ceases to be real play and becomes work. It is often said, and truly, that children work when they play and play when they work. This work attitude appears potentially even in infancy when the child becomes interested in the things he seizes. He examines them with care and even as young as ten months he begins to place them experi-

mentally this way and that. He notices what happens to them as a result of his activity and the different uses to which things can be put. When he learns to use both hands simultaneously and conjointly, this added power enables him to look at two things at the same time, and to compare the object in one hand with that in the other and to place objects in relationship. His doing so is an indication of intellectual development.

Variety in Play

During pre-school years the child's play is of three main types. (1) Active physical play by means of which the child co-ordinates and gains control of his body and its complicated mechanism; (2) play concerned with investigation, exploring and manipulation, that leads to mastery of material and creativity; (3) imaginative or dramatic play of the "Let's pretend" sort into which fantasy frequently enters. During these years children's play is sometimes sociable and shared with one or two others, sometimes it is solitary. Usually it alternates from one to the other. Though each type of play is specially helpful to one or other aspect of growth and provides outlet for physical, intellectual and emotional energy, the child lives and acts as a whole in all his play, and it is this fact that makes it so harmonizing an influence in the unevenness of growth. The personality reveals itself in physical form, in intellectual qualities, in emotional states, but never loses its unity. In active bodily play the child's mind is also active, planning and directing all he does. He remembers past experiences and uses them as a guide to present situations; he observes all that happens. He is alive intellectually and emotionally as well as physically. In fantasy or imaginative play, he moves about, lifting and carrying things, and uses his mind as well as his body in his make-believe. Imaginative play itself is constantly changing into intellectual

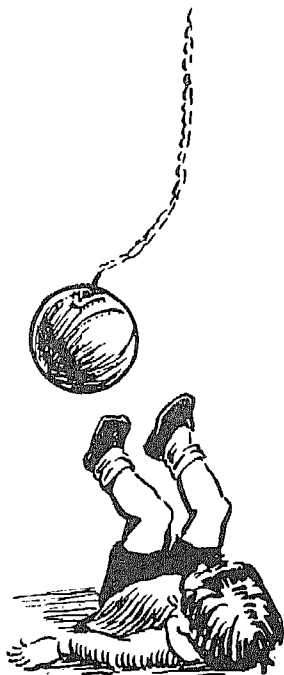
investigation because of the way in which it creates practical situations which are then pursued for their own sake. "In all play three elements are always present, the linking up with the world of human beings, the essential human mastery of material and outward expression of inward experience, but are so interwoven that analysis is well nigh impossible. Yet herein lies the whole meaning of play—and of life. We may endeavour to classify under social—functional and similar headings and produce statistical analysis, but life eludes statistics."[1]

Active Play that Involves the Use of the Body

Play involving bodily movement, though chiefly characteristic of the two to three-year-old persists throughout childhood. It is to a large extent "function play." The child is not pretending to do or be anything and he has no conscious goal or purpose. He runs, jumps, swings and tumbles about just for the fun of it. Though it is without conscious purpose it would, however, be erroneous to think of it as purposeless. No spontaneous activity is meaningless, but arises to take its fitting place in nature's scheme of development. In active play the child aids body growth, establishes neuro-muscular co-ordination and gains control of his movements. The more varied the activity is, the more rapid the growth and all healthy children find it much more difficult, and certainly more fatiguing to be still than to be active. A great deal of the play of a two-year-old is of this active nature, walking and running along paths, up and down steps, climbing and swinging wherever possible.

To acquire physical co-ordination and control the constant repetition of movements is essential, the lifting and carrying of things of all sizes, including objects which require effort to move. As the child becomes confident

[1] Marjorie Thorburn: *The Child at Play*. (George Allen and Unwin, Ltd.)

of his power he grows more adventurous, and it is necessary for him to find toys and apparatus that encourage him to be progressive in his physical development. Provided with the right material and opportunity to use

Good Fun—and Good Exercise

it, the child will put himself through a comprehensive course of physical training as balanced and sound as any expert's plan could be. In free play with toys and apparatus that he enjoys, the child repeats movements over and over again gradually becoming more graceful and skilful, by eliminating any unnecessary movements

or expenditure of energy. There is a great opportunity in the Nursery School for training children in good posture and for checking any tendency towards bad posture. This is an aspect of preventive and remedial work that has not yet been fully explored. The time cannot be far distant when specialists will be attached to the school staff to initiate for individual cases activities involving hanging and swinging by the arms, balancing or whatever is necessary to improve posture or correct unsatisfactory tendencies. Some children by their own efforts and activity rectify many faults when they are given the freedom of a Nursery School, but there are those who need help and guidance.

Active play should take place out of doors whenever possible. In bad weather various kinds of indoor apparatus, such as climbing ropes, rings to hang and swing from, rope ladders, runabout toys and a movable Jungle Gym and stairway should also be available.

Play concerned with Investigation and Exploration

As soon as the child is able to walk and is capable of independent movement he begins to explore his world and experiment with things, investigating their nature and discovering what can be done with them. It is a type of play that persists throughout childhood and characterizes the child's approach to every kind of new material. In its earliest stage, it is stimulated by the suggestiveness of the things that the child sees and handles, and his play is in the nature of reaction and adjustment to external stimuli. Experimental play has neither beginning nor end. The child does not persist in it for any length of time, and as he has little desire to pursue any plan or try to make anything specific, he does not seriously mind interruption. As with experience his interests widen and knowledge and skill increase he begins to be interested in the things he plays with and the

various uses to which they can be put. Intellectual curiosity is aroused and also the desire to satisfy it. From tentative beginnings the child advances to thoughtful investigation and plays in a way that suggests that he is continually asking why? how? if? and answering his own questions and arguing things out in a way that becomes steadily more logical. It is, in fact, the beginning of research. Helped by suggestive material, the child can make good intellectual progress and set forth on a quest for discovery.

The four-year-old who does a great deal of practical reasoning in his play, needs many kinds of adaptable material with which he can experiment and use in a variety of ways. The material should stimulate the use and exercise of sense perceptions and give opportunity for comparing and discriminating between extremes that are in great contrast and those in which the differences are slight. The toys should provide for manipulation in ways that involve judgment and decisions. Such play provides the concrete basis from which abstract reasoning and judgment can arise at a later age.

Play Becomes Work

When as a result of much experimentation the child is thoroughly conversant with varied material and has acquired mastery over it, he begins to use it with intelligent purpose. He thinks, plans and determines before he begins to play what he is going to do. Once this stage is reached the stimulus no longer arises from the suggestiveness of the material but from the child's own intelligence. It is his own ideas and desires and not external stimuli that prompt both his choice of material and the use to which he puts it. This thoughtful experimental play involves the use of past experience, memory, attention, concentration, imagination, and the ability to follow and work out an abstract idea. It is a much more

complex performance than the simple and almost impulsive reaction to outward stimulus with which this type of play begins. It is purposeful from the beginning to the end. The following illustration, given by Charlotte Bühler, serves to show the different way in which a child of three and a half and one of seven will use the same material. Both children found some clothes pegs and began to play with them. The three-year-old put them in a box which he fastened to a waggon, and went about selling them as bread rolls. The seven-year-old, after experimenting with them and the way in which they could be manipulated, began fitting them together, and made an aeroplane, saw-horse and a motor-car. " The seven-year-old differs from the three-year-old child in two ways. (1) He tries to make something with his material; the younger child does not. (2) He tries to discover through his activity the best use for the material, that is, its appropriate use. He uses it specifically. The young child is unspecific, he uses the pegs for a purpose for which they are as ill or well suited as anything else. He has not developed either the power to construct or to treat his material as having specific qualities."[1]

When the child begins to work to a plan and endeavours to make real things, his play should not be interrupted but he should be given the opportunity always to complete what he is doing. He resents interruptions at this stage as much as adults do when engaged in serious work. It is in play of this nature that persistence of effort, concentration and attention are all developed and the child thus prepares himself for real work. When he has learned habitually to follow a plan with perseverence and self-forgetfulness, he attains what Charlotte Bühler calls " school maturity "—that is the ability to undertake and carry through tasks and duties impersonally. If the

[1] C. Bühler: *The Child and his Activity with Practical Material.* British Journal of Educational Psychology, February 1933.

child is constantly interrupted in his play and has only short intervals for it, he does not form the habit of concentration or attention, and remains infantile in this aspect of growth. When this happens the ex-nursery school child is a problem on entering the " big " school, for he is unable to tackle school work or to carry on without constant adult stimulation.

The child approaches each type of material with a twofold interest. He wants to discover all the possibilities of it, and also his own skill in using it. Until he has achieved both he is not able to use the material as a means of expressing himself and his ideas. The child's progress in this way is clearly shown in his painting. At first he is content merely to daub the paint over the paper. It is a way of exploring the " paintness " of paint and of gaining control of the use of the brush. It is purely experimental. Next he begins to play with his own skill, making lines, circles, etc. and when by chance these strokes resemble something, or a teacher asks a tactful question, he decides that he has made a picture of this, or that and gives the name to his creation *after* it is finished. " Look ! look what I've done—its my dad," he exclaims excitedly. A little later he begins to name things *as he makes them*. " I am making the sun, this is the sea," or " now I am doing a boat," and in doing so is still to a large extent inspired by the suggestiveness of his achievement. Eventually, he acquires sufficient control of the material to use it as a means of saying something definite and announces *before* commencing his work what he is going to do. " I am going to paint an aeroplane flying over the sea. I want some silver paint, etc."

" The child passes from primitive pleasure in activity to pleasure in creation and production, an essentially human pleasure. Instead of pouring out energy in activity, we transfer it to material, and find pleasure in

stamping our individuality on material. We express ourselves through it. With this are connected three important experiences characteristic of mankind. While active with material man surrenders himself to it, masters it and puts something new into the world."[1]

A social element enters into play when the child begins to master his materials and to make recognizable objects. It enables others to enter into his play and his thoughts. This was illustrated when a child who had been scribbling with chalks suddenly exclaimed, "I've drawn a man." He was so very excited, though it consisted of only a head, that he took it around for every child in the room to see. Many of them showed great interest in it and laughingly pointed out eyes and nose. On returning to his table he said, "And now I am going to draw a *very* funny man." He did so and on taking that round to be looked at, there was much laughter. Children often join together in play when a definite plan is being worked out, co-operating in a way that is not possible until their interests are objective.

In the article referred to above, Dr. Bühler quotes some interesting tests that were made in America on two groups of children of similar age. One group consisted of institutional children who had little opportunity for collecting things or playing with more than a few conventional toys. The other group was composed of children of poor parents, who played in the streets, and backyards of shops where a great variety of odds and ends of waste material had collected. When these children were tested by the Bühler Development Tests, the intelligence of the children of the poor families was found to be very much greater than that of those in institutions. The difference was even greater in ability to handle different materials. If the child has a variety of material and long

[1] C. Bühler: *The Child and His Activity with Practical Material.* British Journal of Educational Psychology, February 1933.

periods of undisturbed play with it, not only will his general intelligence be stimulated but he will gain knowledge and appreciation of different media and manipulative skill. These are of considerable value when at about eight or nine the creative impulse arises vigorously. This impulse, supported by previously acquired skill, knowledge and keen perception, will enable the child to produce creative work on a far higher level than is possible to those whose play life has been short and play materials scanty.

Making Things

The desire to make things is strong in the child, and construction is a very general type of play. Possibly bricks satisfy this desire more than any other single material, and it is with bricks that he first begins purposeful play. He makes towers, trains and fences at two or younger. Bricks can be used for many different purposes and are equally satisfying to the two and five-year-olds, used either alone, or in combination with other toys. In carrying them about, in constructing simple towers or complicated buildings the child acquires a great deal of sensorial knowledge, e.g., of weight, size, perspective balance and cohesion. Manipulative toys and material, objects that require to be matched, sorted and classified, are of value and help the child to gain manual dexterity, to master his material world, to grow aware of its possibilities and to discover something about the operation of natural law.

When the child becomes interested in making real things, he requires the use of tools and material with which actual objects can be constructed. Hammers and nails, wood and varnish are necessary as well as some training in the technique of handling them.

Because four-year-old children are so independent and grown up, as compared with the two-year-olds,

teachers do not always realize that they are in need of help and direction in their play, and proportionately less is done for them than for the two-year-olds. Where the teacher spends time playing with the four-year-olds and helping them to discover new and more difficult ways of handling all kinds of materials, their play interests are intensified. They begin to model with clay effectively, to make all kinds of complicated machines with their pic-a-bric, and elaborate buildings with their bricks, occasionally calling upon the adult to help them to get things right.

Children require material that becomes progressively more difficult to handle and wider in possibility—things that challenge increasing skill and knowledge. At four years old, though they continue to use many of the same toys as younger children they use them in a different way, and require, in addition to simple bricks, for instance, those of more varied sizes and shapes with which they can make more exact representations of actual objects. The addition of arches and curves, cylindrical shaped bricks, half bricks and triangular ones enrich the possibility of brick play. Unless supplied with plenty of good material, four and five-year-olds become restless and rebellious. The "seniors" of the nursery school should show by their perseverance and absorption in play as well as by the quality of it, the good they have gained from two years already spent in the nursery. Sometimes, however, they are the most difficult group of all. They do not settle happily to play, and are lacking in responsibility, are unresponsive and quarrelsome. Such behaviour is frequently a symptom of psychic malnourishment. Often it is the play life that is not being satisfied either because of inadequate time for play or paucity of play material. Too often toys provided for these big children do not necessitate enough mental or physical effort and are suitable only for fantasy-play—

dolls, teddy bears, toy tools, etc. Those who are adaptable, placid and not very intelligent make the best of such toys, prolong the stage of fantasy-play and live more and more in an unreal world which becomes a way of escape and a compensation for what they miss. The more lively ones become destructive and undisciplined. They need to have real things to do, and real tools to do them with. If they are constantly frustrated by inappropriate material or poor tools, this serves to increase their rebellious tendency.

IMAGINATIVE AND FANTASY PLAY

The emotional life of a young child is intense. He is very easily provoked and impulses often rise suddenly and overwhelmingly. He cannot deny them or keep them bottled up. They burst forth as either anti-social behaviour, demonstrations of great affection, in temper-tantrums, or are expressed in play. Play is, in fact, the great safety valve, and in it the child can give free expression to tenderness or hostility—to love or to hate. Doll play, pretending to be " mummies " and " daddies "—both those who are tender and those who beat their children—playing house, hiding in cupboards—such play is characteristic of nursery years and reaches its height at about three and a half to four.

Imaginative play is very varied. The child sometimes plays about things that interest or puzzle him. " I will be all these things in order to understand them," is his unconscious thought. He will meow like a kitten and want his milk in a saucer or he strides about shouting " Bottles and Iron " or races along like an engine or motor-car. Also he plays at impersonating people.

This imitation of people and things and the dramatizing of past experiences is a kind of remembrance in action. Experiences that have impressed him will be the subject of games, such as a visit to the country, a ride in a train or

bathing a new baby, just as with older people these are the things of which they talk. These games are really a living experience to the child and not dead or slavish imitations. As an artist in painting a landscape does more than reproduce the objects present to sight or memory, so the child—who is himself an artist in the way he uses play as media for self-expression. When he is playing about past experiences, he invests the incidents with the meaning they have for him, and expresses his wonder, perplexity, or enjoyment, his fear, anxiety or anger. This living over again of past experiences gives relief to any emotional excitement that the incidents may have aroused and is one of the ways in which the child builds his experience into himself. " A child went forth and the object that he looked upon became part of him for the day, or a certain part of the day, or for many years, or stretching cycles of years."[1]

Imitative play, in which the child assumes different roles, reveals the close correspondence that exists between inner and outer stimulus. Though the environment remains the same, the things chosen to be played about change as the child grows, and vary from child to child. " The outer factors of the environment may be responsible for the material of play—the things a child imitates. But it is the inner factor of play-instinct that alone determines when and how imitation is to take place, for the unconscious choice made of the models, as well as the way they are grasped and worked up, entirely depends on the natural disposition and the inner influence of development and differentiation."[2] At one time the play will be about mummies and babies—at another it will be motor cars or the postman, for with growth interests widen, and environment is extended. Sex too, influences the choice, a brother and sister of the same age will play about different things in the same environment, the girl

[1] Walt Whitman: *Assimilation.* [2] Stern: *Op. cit.*

probably choosing doll-play and the boy play with engines or motor cars.

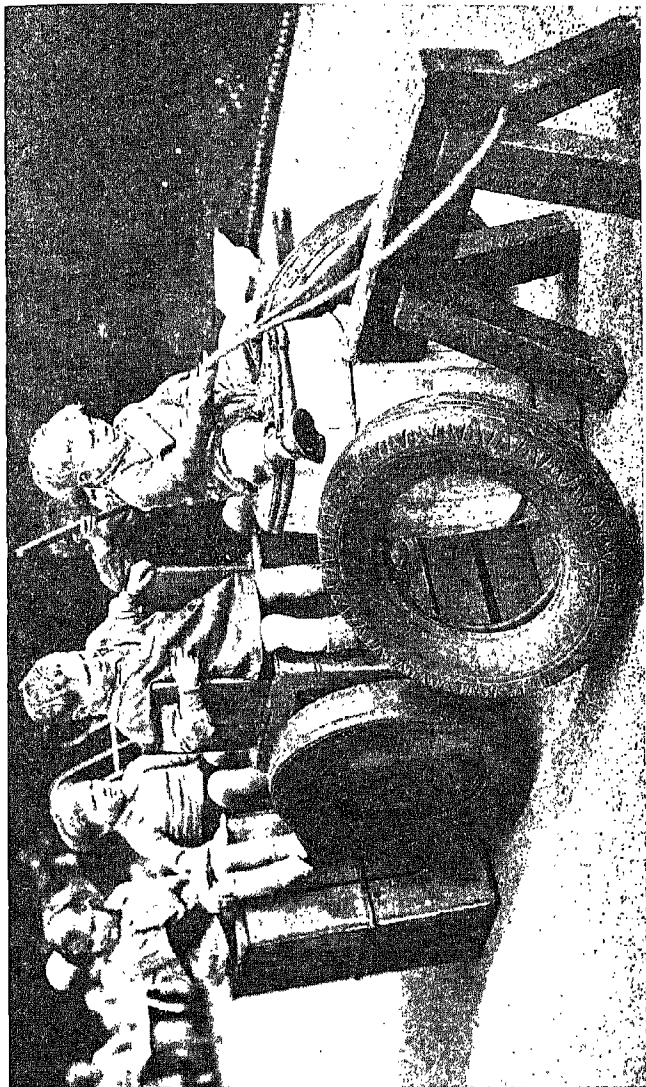
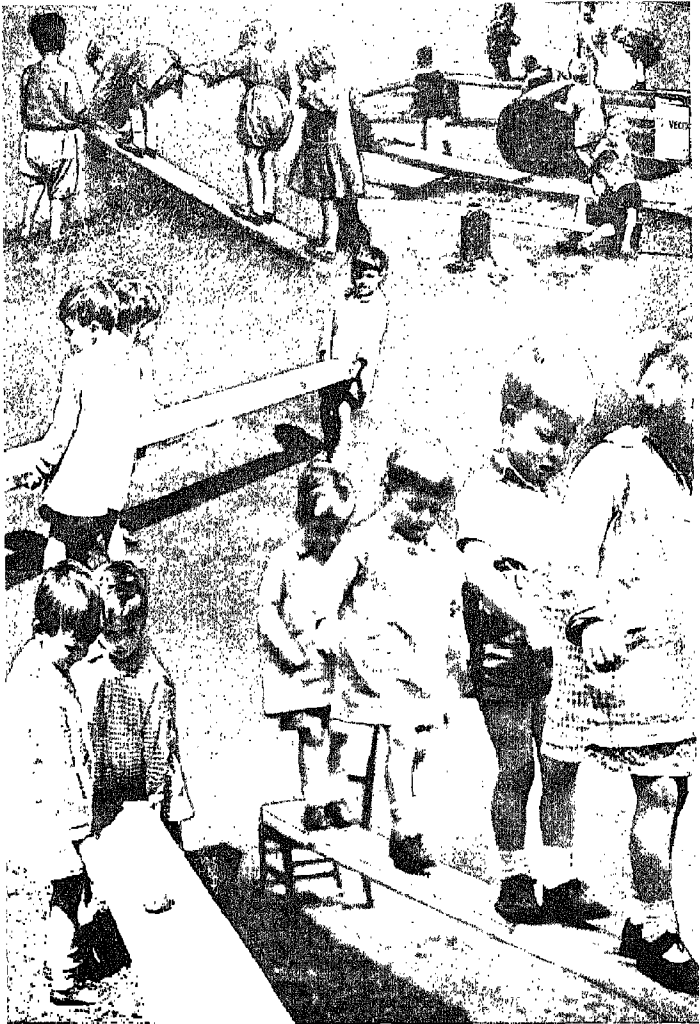
In impersonating people whom he loves and admires the child, by identifying himself with such people, tends to absorb them and their characteristics into himself. Hadfield speaks of the nursery years as the time when ideals are formed, and says that the ideals that a child acquires at this age, stimulated by the character and conduct of people surrounding him, have a marked effect on the development of his character. Thus it is important that adults who surround the child, and are closely connected with him, and who, because of this intimacy, provide the subject matter of much of his play, should be careful to give him ideals worth copying, and provide him with situations that are helpful and strengthening to inspire his play.

Much play is of the wish variety. The child, conscious of his smallness and lack of strength, plays at being a big, strong man, doing great deeds. Such play gives outlet for feeling of annoyance or revenge, and is a kind of protest against a sense of inferiority and helplessness in the presence of unmanageable objects or dominating adults. Scolding a doll, beating a teddy bear, whipping a hobby-horse, stamping on toys, is an outlet for emotional tension and makes it "easier for a child to control real behaviour and to accept the limitations of the real world."[1] Teachers must learn to distinguish between the rough and careless use of toys which occurs because the child is lacking in co-ordination or a sense of order, and fantasy-play in which the toy is used symbolically. Carelessness and rough usage call for training in the protection of possessions, but when the toy is used symbolically the child must be left free to give an outlet to his feelings. Such play has a therapeutical

[1] Susan Isaacs: *Intellectual Development in Young Children.* (George Routledge and Sons, Ltd.)

value, and if it is prevented bad social conduct or emotional problems may in consequence develop.

Sometimes the child plays about things of which he is afraid, big dogs, sudden noises, angry adults, etc. There are many things that cause fear to which the child cannot give expression in words which is the adult way of dispelling fears. Play is the child's language, and he plays out these fears and anxieties and so overcomes them. Independence, for which the child fights so valiantly, brings with it consciousness of self and conscience and feelings of guilt soon appear. It often happens that when a child chastises her dolls she is playing that she is her own mother punishing her. It is indicative of anxiety. The child sets himself standards that are frequently beyond his powers of attainment and punishes himself by "taking it out of" his toys. The influence of the unconscious on play revealed by such conduct cannot be dealt with at length in a general analysis. That is, moreover, more the concern of the psychologist than of the young teacher.

Children become completely absorbed in imaginative and imitative play and for the time being they *are* the people they play about. A long skirt or a piece of material twisted about them, a shawl, or even such simple "properties" as a handbag or shopping basket are eagerly seized upon to convert Sheila into Sheila's mother. Voice, facial expression, physical actions are all adopted in exact imitation of the adult. Houses are constructed with chairs, tables, screens or anything handy, complete with imaginary doors and windows. Chairs are turned into motor cars ; a chalk line is declared to be a fireplace. Yet absorbed as the child becomes and realistically as he behaves, he never for a moment believes that the chair on which he sits is actually a motor car, or that Tommy has really turned into the milkman. It is all pretence. "Fantasy may lead him to create

Waste material leads to inventiveness

A plank as a plaything

make-believe situations, but he continues to feel reality limiting him in that situation, just as we do. Even when he gives himself up to complete realization, he knows that it is make belief."[1]

Games of pretence, invented by teachers are very different in their effect and may easily be a source of confusion to the child. When he himself invents his play the imaginative situations and fantasies are expressions of himself and, as such, have meaning to him that an adult trying to feel like a child can never realize. When a teacher joins in play of this sort, she should let the child be the leader and should endeavour to carry out his ideas.

The line that divides the imaginative from the experimental is a thin one and these two types of play constantly run into and replace one another. A child, building a garage and trying to make it as much like a real one as he can, will suddenly abandon the task, in order to dash about the room like an imaginary motor car, and back in and out of his newly constructed garage. Conversely a child absorbed in imaginative play with a milk float, calling "Milk! Milk!" and selling it to imaginary customers, will forget it in a new-born interest in the wheels of his float. He will examine them to discover how they work, and fetch other wheeled toys for comparison. Imaginative and fantasy play continually give rise to situations that are "then pursued for their own sake and thus lead to actual discovery or verbal judgment and reasoning."[2]

If the play experiences at two and three years of age are fully satisfying, emotional and intellectual development proceed normally, provided of course the child is cared for sensibly. By five years of age, or thereabouts, fantasy-play decreases as the child's interests are turned in

[1] Susan Isaacs: *Intellectual Development in Young Children.*
[2] Susan Isaacs: *Op. cit.*

the direction of doing and making real things. "In later development, direct expression of fantasy becomes more closely limited to imaginative art and literature, yet it leaves a permanent representative behind in the realm of thought itself, in the shape of disciplined imagination of "as ifs" and of scientific hypotheses."[1]

It has already been shown that children's play-activities follow a definite sequence for "it is a law of nature, a law of mental growth that one performance should precede another at certain steps of maturity."[2] Thus the teacher who systematically observes the trend of each child's play should know whether or not he is developing satisfactorily. A form in which she can keep a record of the most essential features of the child's play and of his behaviour generally is given in the Appendix.

If a child is found not to be progressing, one of the best ways to help is for the teacher to put him in touch with play-material likely to quicken the backward impulses or to stimulate greater efforts. In guidance clinics children are healed and re-educated through play. The right toys—right in relation to the child's stage of growth and individual need—provide the best means for education and re-education.

[1] Susan Isaacs: *Op. cit.*

[2] Gesell: *Guidance and Mental Growth in Infancy and Childhood.*

CHAPTER XI

PLAY MATERIAL

"If we were more primitive, we could perhaps give less thought to the provision of play material, but in becoming to some extent civilized we have unwittingly allowed ourselves to be deprived of elementary play material, not realizing its significance. We have provided faulty substitutes for it."[1] Sand is a never failing source of interest especially to the two and three-year-olds and many things can be done with it and learnt from it. Sand pits should be deep enough to permit real digging and in close proximity there should be shelves or cupboards full of buckets and spades, pots and pans, containers of various sizes and shapes in which sand can be put or moulded. These should all be of a non-rusting material, unbreakable and free from sharp edges. Filling and emptying is the chief interest of the two-year-old and he should have many sizes of pots with which to make his "pies." Children of four and five want to do more with the sand and like to use sieves, scoops, funnels, measure-pots, weights and scales. It is preferable for these tools to be used at a sand table, though if the sand pit has a wide shelf surrounding it, which can be used as a table, this serves equally well. Water should be available for wet sand is very suitable for moulding. All children want to play with water, "who is very serviceable unto us and humble and precious and clean."[2] Its appeal is irresistible at all ages, and play with it is deeply satisfying to a child both intellectually and emotionally. Paddling

[1] Gwen Chester: *The Child's Needs and His Play* in *The Growing Child and His Problems*. (King and Page.)
[2] St. Francis.

pools and fountains are a never-ending source of delight, but much satisfaction can be provided with zinc-lined water tables or even an old bath if, in addition to the water, there are funnels, scoops, tubes for syphoning, cups, measure-pots, bottles and jars of all sizes as well as floating toys.

Children should be given opportunity to make a mess with water, or water and sand. The impulse to do so is strong, and has to be restricted in most homes where order is necessary. In addition to "messing about" with water, children can also use it for games of skill, filling narrow-necked bottles through funnels from jugs, ladles and other objects. This kind of activity can gradually become a skilful operation if arranged in a way that makes the child aware of uncontrolled action. The water can be coloured—and a white American cloth cover be put on the table, with mop handy to wipe up every drop spilled. Children in one school learned to ladle soup and pour milk admirably as a result of practice in ladling and pouring coloured water set out as a game of skill on a specially prepared daintily arranged table.

Toys and play material should be attractive to look at and to handle. The very young child is not self-directing in his activities, but is stimulated by the suggestiveness of the things surrounding him. Objects that are attractively coloured, pleasant to hold and to touch, are more encouraging to play with than ugly, shabby and broken toys, unpleasing both to see and to use. This is not true of personal possessions and a toy that has grown old and shabby through much use is still loved by the child, who remembers it as he once saw it and who surrounds it with feelings and association. But nursery school toys are not personal possessions, and children will never take care of them and enjoy playing with them unless they are attractive in appearance and pleasant to the touch.

Tactual sensitiveness is the first of the senses to develop and is very highly evolved even at birth. The fingers of the nursery school child are particularly sensitive and rich experience can come to him through his hands. With growth the skin thickens and a great deal of the sensitiveness has already disappeared by the age of seven. It is moreover easier to train children to take care of their toys if the toys are clean and unbroken; they delight in pretty things and desire to preserve them. Worn, broken or soiled toys do not inspire care and give rise to rough, neglectful usage.

Nursery school toys should be durable; fragile, easily broken toys are unsuitable except for special occasions, such as birthday parties. Wooden toys are more suitable than those made of metal, and should of course be free from splinters.

Low cupboards are better than shelves for storing toys as they get less dusty, and the child is provided with useful experience in the opening and closing of doors. Sliding doors which take up no space are practical in a small room. Shelves that can be adjusted in height to take large or small toys are practical. The cupboards should not be deep, but should have narrow shelves on which it is possible for all toys to be seen and reached. Where shelves are deep, some toys always get pushed to the back out of reach, and as the young child tends to take the first thing he sees, he does not exercise choice unless they are so arranged that he sees many things at once. Where toys are well set out children can often be seen wandering past the shelves, looking at this and touching that before making a choice, as adults do in choosing a book from a library. The motive that prompts them both is the same.

For the two-year-old, who does not spend much time in selection, each shelf of the cupboard should contain a choice of toys. The same selection can be repeated in

many places, and as these young children do not need a great variety, this arrangement is simple and easy. It also simplifies the replacing of toys after use which every child should be trained to do from the beginning. For older children who choose with more discrimination, and are capable of remembering where things are kept, it is an advantage to have toys classified, such as cupboards for dolls, and others for fitting-in toys, or for plastic material, etc. This orderly arrangement is good training for the child, and the interior of cupboards can be adapted accordingly. Bricks are difficult to house. For the youngest children who do not need many at a time, they can be stored in trucks and carts, which also provide a simple means of moving them from place to place, or kept in strong linen bags with a thick cord running through curtain rings at the top. They can then be hung on hooks. These bags can be easily carried about, and make putting-away time fairly simple. For older children who need many bricks for their play, larger carts can be used as a store, or one cupboard can be used or a corner of the room reserved for brick play.

Special display tables, or open shelves are of value for setting out something different each week. Many toys are overlooked or forgotten and much useful material remains unexplored, unless brought to the children's notice at intervals and this special display often succeeds in awakening fresh interests and stimulating new kinds of play. A birthday cupboard in which very special toys are kept has been found attractive, for children dearly love a treat. In this, all kinds of toys beloved by children but of a special character, such as dolls with silk dresses, super-prams, tea-sets, etc., can be stored, and the birthday child be permitted to choose a special toy for the day. A great deal of fun is provided by mechanical toys which are often amusing though valueless for daily play. They have little or no educational value, but serve as an

occasional entertainment and provoke much laughter at a birthday party.

Play Material for Different Ages

In no case are the lists below complete. The material listed is suggestive of types of suitable toys and playthings. It is inadvisable to have too much material (i.e. too many kinds) available at the same time—and better to ring the changes occasionally. There should be a large number of popular toys as this prevents jealousy and disputes.

Two-year-olds

1. Climbing frames with rungs small enough in circumference to be firmly clutched, and sufficiently widely spaced to permit climbing in and out.

Small slides with steps, either leading up to the slides or up to a platform from which the children can jump.

Steps can also be made of three or four square, hollow boxes, each smaller than the other and placed on top of one another. They should be firmly fastened together; this makes a raised platform which children can run up and down, and from which they can jump.

Planks, at least nine inches wide, placed two or three inches from the ground, for balancing and jumping.

See-saws; large balls; runabout and pull-along toys; animals on wheels; wagons and trucks; boxes with or without wheels but with ropes attached in which objects can be pulled about; push-about toys, such as prams, carts etc.

Low and very safe swings can be used indoors as well as out if suitable hooks are provided in doorways. Another useful toy for doorways is a suspended ball which children can kick while lying on their backs. This is a very strengthening exercise for frail legs and backs.

Toys for riding that take the weight from the legs that are not yet very strong, i.e., hobby-horses on wheels on

which the child can sit and push himself along with his feet on the ground. Simple pedal-cars.

2. Tins, cartons, and every kind of box that opens and shuts into which small objects can be placed. Glass containers that chip and break are unsuitable. Wooden boxes should be made safe from splinters. Tins should be rustless and have no sharp edges or corners. There should be small objects for filling the containers, i.e., beech-nuts, shells, conkers, lentils, beans, peas, etc.

3. Fitting-in toys, e.g., Montessori cylindrical insets, simple form-boards, peg-board, nests of boxes, baskets or dolls that fit inside one another. Objects with holes in which children can poke fingers and sticks, e.g., pyramid mosaics, pegs and shapes, large wooden beads of divers shapes to be threaded on boot-laces with tags or cords with waxed ends that neither invite nor necessitate sucking.

4. Bricks in small quantities. The two-year-old does not build very much except towers and fences. Bricks are chiefly used for physical exercise, being carried or trundled from place to place, and for fantasy-play. They should be large enough to require hand and not finger manipulation, i.e., about two or three-inch cubes, or if brick-shaped $3 \times 2 \times \frac{1}{2}$ inches approximately. Wooden trains, of which parts can be linked together on tongue and groove principle and without wheels.

5. Dolls of the simplest kind, more suggestive than detailed. They should be big enough to be nursed comfortably; washable rubber dolls are specially suitable. They should be dressed in one or two simple garments, that come off and on easily and are without fastenings. Dolls' prams and beds with plenty of covers.

6. Sand for digging, buckets, spades, scoops and receptacles in which sand can be moulded and pies made, and different kinds of receptacles that can be filled and emptied.

7. Picture-books made of firm material. The pictures should be very simple and deal with familiar things—domestic animals, children, motor cars, aeroplanes, men and women and situations within the child's experience.

Picture cards mounted on cardboard, glazed and kept in boxes are enjoyed, and are inexpensive to provide.

Three to Five

1. Higher and steeper slides approached by flights of steps; climbing frames on which children can become adventurous. This frame should be so constructed as to include a section from which children can hang by the hands and swing. If, in addition there is a railed-in platform up to which children can climb, this stimulates a great deal of play on the platform to which various toys are carried, and also underneath, as it makes an excellent "home" or "getting into" place. Large packing cases sandpapered to avoid splinters for lifting and pulling about and turning into play-houses. Barrels and logs for rolling about; these stimulate playing together in order to carry them from place to place. Punchball, knotted ropes for climbing, suspended ropes ending with metal rings from which children can swing by the hands, or in crossbars of wood on which they can sit and stand to swing. Rope ladders, and trapeze. Platform for jumping from. Balancing planks with supports of different heights, ranging from six inches to a foot, which children can adjust. The planks can range from two to six inches wide. This material often leads to useful experiment with inclined planes, improvised see-saws, jauncing board.

2. Runabout toys, e.g., wagons, trolleys, wheelbarrows. These should be big and strong enough to carry objects and give rides to other children; they encourage social play. Tricycles, motor-cars and other propelled vehicles. Skittles, quoits, target games, bats, balls, racquets, hoops, skipping ropes, reins.

3. Fitting-in toys, and threading toys, as provided for two-year-olds, but of a more advanced kind. Montessori geometric insets and other form-boards, peg-boards, beads of various sizes, both wooden and china. Jigsaw puzzles are popular provided the pieces are not too small or too indefinite in shape to permit the child to succeed in fitting them in. In working with them he seems to

examine shape rather than try to build the picture. When buying jigsaws the teacher should therefore give more consideration to the shape of the pieces than to the picture.

4. Bricks of varied shapes and sizes and in greater quantities than are required for the younger children. after many experiments the general opinion is that the most useful bricks measure $6 \times 3 \times 1$ inches with variation in length, i.e., $3 \times 3 \times 1$, $12 \times 3 \times 1$, $18 \times 3 \times 1$ and possibly a few $24 \times 2 \times 1$. The largest number should be the first and second mentioned: A few cylinders, arches and triangular blocks increase possibilities and these should be to scale; cylinders 6×3, arches 12×3, and triangles 6×3, 150 pieces all told are a reasonable quantity. They can be made by any useful carpenter from non-splintering hard whitewood. Large hollow blocks with hand hole for lifting are suitable for out-of-door building. They should be of material seasoned for all weather so as to be useful for keeping out of doors. Many teachers regard these as undesirable as they are so light that they are apt to give a false conception of weight in relation to bulk.

5. Toys that do things such as cranes, dredgers, windmills, are very valuable; also trains that link together, and constructional material such as pic-a-bric and matador. Laughter-producing toys like "Crazy-Ike."

6. Sand-play tables, as well as sand-pits, scoops, funnels, sieves, weights, scales, measure-pots of varied capacity, paper bags, etc. Water-play zinc-lined tables are obtainable, but a common bath or anything that holds water will suffice; measure-pots, ladles, spoons, funnels, rubber tubing. There should be a collection of things of various densities—things that float well out of water, things that float mostly submerged, things that sink slowly and others that sink quickly. Ice if obtainable is interesting.

7. Material that stimulates the use of the senses and by exercise develops a fine sensory discrimination, in regard to colour, form, size, texture, weight, sound, touch, etc. Montessori sense-material is suitable.

8. Pattern and picture-making material. Mosaics of all kinds, shapes for tracing and colouring with crayons,

Waterplay : a medium for fantasy and experiment

Real tools make fingers skilful

either Montessori metal insets, which are suggestive for designing or similar objects, paper, crayon, paints, brushes.

9. Plastic material. Clay, plasticine, putty, dough, sand used with water.

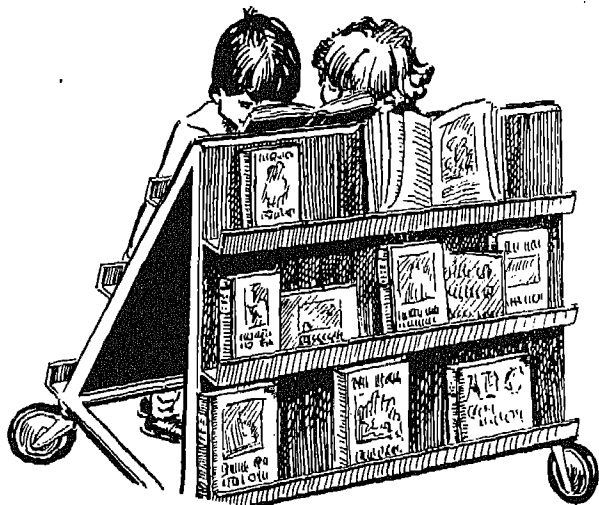
10. Dolls. Boy and girl dolls including washable baby dolls, all of them more realistic than those required for the two-year-old. All accessories that make for doll-play, baths, prams, tea-sets, beds and bedding, feeding bottles. Dolls' clothes in sets with simple fastenings. Good sense training can be provided by having the sets of different colours. Chests or boxes for storing clothes. Cardboard-filing chests are useful.

11. Playhouses, either permanent or easily erected out of adjustable screens. All the paraphernalia that makes for "living" in these houses, i.e., furniture, kitchen utensils, tubs, mangles, irons, clothes line, pegs, clothes horses, brooms, pans and dusters. Shops or the means of constructing and equipping them, with goods for sale, i.e., clay fruit and vegetables, boxes, tins, cartons, bottles. Scales, telephones, cardboard pennies, paper bags, notices, price cards, etc.

12. Dressing up material. Garments, lengths of stuff, lace, silk, georgette, ribbons, hats, umbrellas, gloves, handbags, shopping baskets, also uniforms for policemen, postmen, conductors. These should be stored suitably in an accessible place.

13. Picture books, which can be housed on a bookshelf and kept as attractive as all books should be. These should be more advanced than those provided for two-year-olds and include pictures of well-known stories and rhymes. It is an advantage if a special corner can be reserved for "the library" with a cloth upon the table, or a table of a special colour to encourage children to handle and use books properly. A book trolley makes a good portable library. Picture cards, mounted on cardboard and glazed, kept about a dozen in a box, suitably chosen postcards similarly stored. These can also be kept in "the library."

14. Waste material, which can be used either alone or

combined with other toys has been already mentioned. This material because of its miscellaneous nature is difficult to house, but good use can be made of orange boxes, in the sections of which the material can be more or less classified. Wood; odd pieces and circles that can be used as wheels, such as Gloy-tops, cotton-reels; meat skewers, orange sticks, used matches. String, lengths of wool, bodkins,

A Book Trolley

coarse canvas, tape, rubber bands, paper fasteners, adhesive tape. Boxes of all shapes and sizes, from pill-boxes to shoe and hat boxes. Cardboard, pliable and stiff, cylindrical rolls and miscellaneous material, such as ribbon bolts; catalogues, fashion books, wallpaper books, scissors, pencils, paper of various kinds, i.e., wrapping paper, unprinted newspaper, crepe tissue in all colours, corrugated, transparent cellophane.

The advantage of an outdoor rubbish heap will be dealt with in the chapter on gardens.

15. Bubble-pipes. These should for preference be an

individual possession kept in a child's locker or drawer. Otherwise they must be treated with a strong disinfectant after use.

FINGER PAINT

Specialized material such as finger paint gives children great delight by enabling them to make a splendid mess and to dabble fingers and hands in it. Finger painting is a good beginning to a form of creative activity of considerable importance in early years—the making of patterns and the painting of pictures. Finger paint is a soft creamy substance that spreads easily and smoothly over sheets of paper or American cloth that have been previously damped with a sponge. It is easily removed from clothes and is non-poisonous, both useful qualities as children get much paint on their garments and messy fingers have a tendency to go into mouths. The paint can be obtained in many colours and provides excellent colour training in the mixing and blending that children delight to do.

The texture of the paint when spread lends itself to the gliding movement of hands and fingers, and as the child draws his patterns and his pictures with his fingers he gets an agreeable feel of the form of the shapes he makes. With this, as with all new material, the child's first reaction is one of experimentation. He spreads the paint about, gliding his fingers this way and that. Soon, however, as patterns or pictures are suggested by the shape of his movement he finds that by a twist of the fingers or by a continuous hard and moving pressure of the thumb, he can create forms. He begins to do so with purpose. The effect is so stimulating that he soon desires brushes and paper by means of which permanent and real pictures can be produced.

POWDER PAINT

Large sheets of kitchen paper or any cheap paper such

as unprinted newspaper should be fastened to boards, easels or any upright surface at a height comfortable for a child to work at. Powder paints are cheap and suitable and can be obtained in good colours. These should be mixed with a fixing medium, and made ready for use. Long-handled brushes should be provided and the child shown how to hold them. At first children put so much paint on the paper that it trickles down, so unless easels with paint pot shelves are available it is necessary to cover the floor.

:HAPTER XII

E TEACHER'S PART

preceding chapters suggestions have
: way in which the teacher can co-
owing child, helping him to adjust
, and to acquire habitual responses
different occasions and at the same
himself. Nevertheless a separate
her is necessary as there are many
nat are too general and too important
y other chapter.

ol teacher has a role to fill that is in
t from that of teachers of older
needs to be mother, nurse, teacher
It is a task for which few, if any,
by nature alone. Love of children,
for managing them and the practical
h so many young women possess,
, resourcefulness, a sense of humour,
liness that facilitates social contacts
ple, are, though excellent and essen-
sis, not in themselves enough. She
ing of social conditions and the many
exist to ameliorate them, especially
dren. She should study physical
ors that hamper, even if they do not
h. It is as necessary for her to be
gnize symptoms of ill health as to
g with behaviour problems. It is
me adults who have " the equivalent

examine the roots. However delicate his specimen may be, his cloistered wizardry will succeed in bringing it into flower."[1] Though such teachers exist they are very rare. The "born" teacher requires also special training if the educational possibilities of the nursery school are to be fully realized. She needs an acquired technique if her love is to be made fruitful in service.

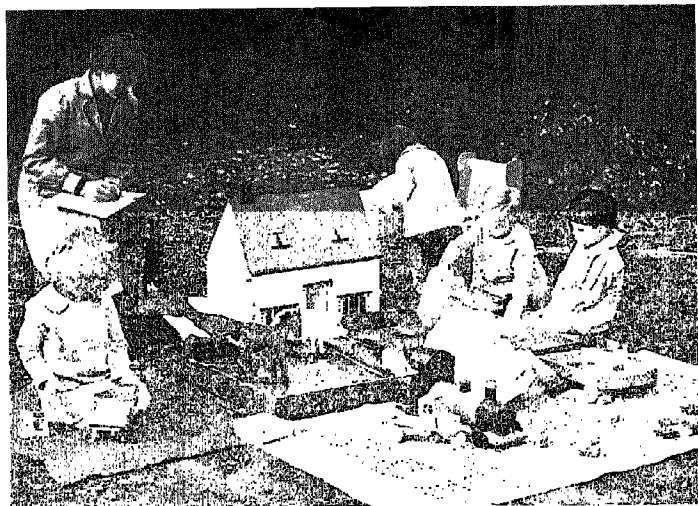
"There is only one road to progress in education as in other human affairs: science, wielded by love. Without science love is powerless, without love science is destructive. All that has been done to improve the education of little children has been done by those who love them . . . and those who know all that science could teach on the subject."[2] In this statement Bertrand Russell brings together the two essential qualities of the nursery school teacher—knowledge of the laws of growth and the way to collaborate with them, added to wisdom and spiritual understanding born of love.

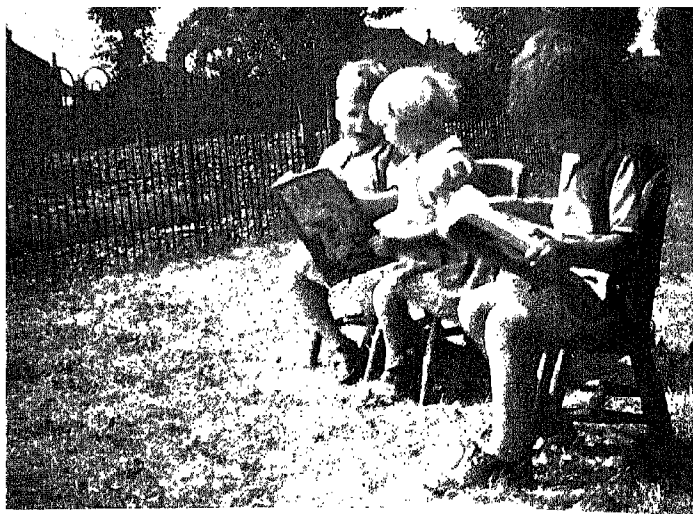
The Value of Observation

Knowledge of children can be acquired through study of researches made by other workers in the field and by first-hand observation. Both these approaches are essential and should supplement each other. "He who earnestly desires to gain deep understanding of the greatest drama of evolution—the growing to human estate of our children, must be prepared to realize that this is impossible without very thorough preparation."[3] Of first importance is the cultivation of a scientific attitude and approach that disregards prejudice, accepted beliefs and opinions in an endeavour to see the child as he really is. Reference is so often made to the "average" child—

[1] W. de la Mare: *Early One Morning.* (Faber and Faber.)

[2] Bertrand Russell: *On Education.* (George Allen and Unwin, Ltd.)

[3] Karl Bühler: *Mental Development of the Child.* (Kegan Paul, Trench, Trubner and Co., Ltd.)

The teacher's first duty is to study her children

A lesson in hand-washing

Picture books in the nursery and well-illustrated storybooks for older children should be kept in good condition

but "averages"—like statistics can be elusive and misleading. "The average age of three children who are respectively 1, 3, 14 years of age is 6, but what relation has that figure to the three children? There may be appropriate examples of what is deemed an average intelligence or intellect, but where shall we find an average mind, soul, or self? If that is our query we might as well live in wait for the average of nineteen sunsets or seek the average pot of gold at the foot of the average rainbow. The only human being competent to reveal what any child is is that child himself . . ."[1]

The teacher should endeavour to cultivate the power of exact observation of the children with whom she is dealing, not the group as a whole, but each child one by one in order to be able to understand more than a good nurse does. She should endeavour to avoid, as far as possible, the tendency to appraise a child until her study has been many-sided and carried on for a considerable time. This is particularly true of children who for any reason appear to be difficult or in need of definite guidance. It is only fools who "rush in where angels fear to tread," and a false beginning in dealing with a child can often prevent help from being effective later, because of the attitude it has aroused. Wherever it is practical to arrange—through the interchange and sharing of duties—team work among the school staff in compiling data about each child, it is desirable to do so in collaboration with the doctor and the nurse. Each teacher can follow the line of research that most interests her, and if conferences are held periodically, in which all aspects of the health and behaviour of particular children are discussed, a truer estimation of their development and needs can be arrived at than if carried out by one teacher alone. The scheme for studying children in the Appendix could become the basis of such team work. To quote Jung in

[1] Walter de la Mare: *Op. cit.*

this connection: " Whatever we look at, however we look we see only through our own eyes. For this reason a science is never made by one man by but many."

No true assessment can be made until every aspect of the child's life has been investigated—health, past history, home conditions, the attitude of parents as well as the child's behaviour in nursery school hours—and this should be continued over a considerable period of time. First impressions of children are often very deceptive. Many children whose home conditions are unsatisfactory appear to be dull and backward when first they enter the nursery school and are often far below the developmental standard of their age. Yet in a few months' time such children may show themselves to be normal in every respect.

Observation should continue for a time also because children pass through temporary phases and adopt forms of behaviour that are not necessarily typical of them but which are due to temporary conditions, perhaps of health, perhaps the presence or absence of a particular person at home or school. A child's own emotions sometimes act and react on one another in a way that causes surprising consequences. For instance, it is often the gentle, sensitive child who becomes aggressive, aroused by an uprush of sympathy for some child or adult whom he feels to be treated harshly. Aggression in such a case is but a passing phase, and it would be misleading to write that child down as " aggressive " as it would be to deal with the aggression itself. It is the other emotion, sympathy, that is the dominant characteristic in such a case.

Close and continuous study of children and their play will provide the teacher with a mass of material which is of little use until evaluated. With this object every teacher should make a comprehensive study of some of the valuable literature that has been published during the

last twenty years during which research has been world-wide. Karl Bühler believes a study of the first year of life to be as important to the teacher as embryology is to the biologist. Knowledge of the usual course of child development will help her to use her own observations. It should also enable her to decide whether each child is growing satisfactorily and to recognize deviations from the normal; intellectual, emotional or physical. This should help her to determine when to render first-aid or when the services of a specialist should be sought. Early symptoms of physical or nervous defects in sight, hearing, posture, etc., if detected promptly, can be rectified and serious troubles be prevented. Emotional disturbances, intellectual retardation and social maladjustment can be easily recognized by a trained observer. If quickly taken in hand the possibility of future ill-health can be eliminated.

The Teacher's Temperament and Attitude

Children readily become attached to their nursery school teachers who, when they are loved, come near to the mother in the confidence they inspire. Being very easily influenced they are inclined to accept their teacher's standards. This throws a great responsibility upon nursery school teachers, many aspects of which have been discussed in the previous chapters and need not be repeated. The teacher must obviously be unfailingly just and fair in all her dealings, must never break a promise nor betray a trust. If she falls below this standard not only does she forfeit any influence for good that she might otherwise possess but—what is more serious—she may undermine the child's faith generally and mutilate, even if she does not destroy, the early shoots of the religious life. Children are very quick to read facial expressions and to sense the presence of emotions that adults often think hidden. Depression,

distrust, dislike, impatience, however well suppressed, are often revealed in tones of voice or tension of muscles that the alert ears and eyes of children rarely miss. Teachers who are habitually anxious, suspicious or irritable and those who suffer from what Burt calls unkindly "the teacher's ingrained tendency to rebuke," invariably make children restless and sometimes quarrelsome. Children are helped most by those who are naturally cheerful, optimistic, and friendly. "A quiet self-command is an indispensable trait in a teacher. It is not the same thing as a deliberate self-control which comes as a result of effort, but, on the contrary is an outward expression of an inner poise. If ever that Scripture phrase 'in quietness and confidence shall be your strength' holds true, it is in the realm of child training."[1] The teacher who is quietly confident, consistent in behaviour, calm and dispassionate, inevitably creates an atmosphere in the nursery that brings out the best in children. They become spontaneous, natural, fearless and friendly. The good teacher—like the good parent—will be a sustaining influence, but relatively passive. She should give the child a feeling of security and of being wanted for himself and strengthen this feeling by a well-ordered day in which he feels at home and knows what to expect.

Most people live up or down to the opinion held by those with whom they are closely associated. With children this is particularly true and their behaviour is much influenced for good when they know that teachers love them and believe in their essential goodness. This does not mean that the teacher should live in a fantasy world with eyes closed to the many undesirable forms of behaviour which children, on occasion, adopt. It means that she should be able to differentiate between conduct that may be extremely unpleasant and which she

[1] L. Wagoner: *Op. cit.*

must help the child to alter, and the child himself, whom she must love under all circumstances. If she investigates the cause of the behaviour, the knowledge gained will often serve to throw new light and create new feelings. *Tout savoir c'est tout pardonner.* She can then help the child with gentleness and good humour to alter what is awry, to overcome his weakness and re-establish himself in his own confidence. The relation between child and teacher should be made pleasurable. Force should never be allowed to spoil it, either the force of the adult in authority or that of the child winning his way by bad behaviour. Courtesy—a flower of the spirit—is not always valued in dealing with children as fully as it is expected from them, yet it is of very great importance. Speaking about children in their presence should always be avoided. Even if they cannot hear what is being said, the fact that they are being discussed makes for uneasiness and self-consciousness and has as bad an effect as hurrying them along by a push, interrupting them when they are speaking and not paying proper attention when being addressed by them. These are acts of discourtesy which adults do not adopt to one another, but do not always avoid with children. Nicknames are equally discourteous, and it may have a permanent deleterious effect on a child to be called "butter fingers," "silly billy," "fidgety Phil," "clumsy Jack," "bundle of rubbish," etc. Children resent them only slightly less than the patronizing "clever boy" or "nice girl." A sense of fun is an indispensable qualification, but it should not take the form of nicknames. Readiness to laugh with children at their own fun, and to help them to laugh when situations are difficult goes far towards the solving of problems. Laughter which makes for good physical health is itself evidence of good mental health. The teacher who has not learned to laugh does not belong to the nursery school. An adult who has forgotten

how to play is also less likely to be a success than one who can enter into children's games with enjoyment.

It cannot be stressed too often that the teacher's influence is greatest when she is least conscious of it. It is what she is that influences children who, at this age, are prone to identify themselves with the adults they love and to copy them both consciously and unconsciously. Her every gesture, word and facial expression, the daintiness and suitability of her clothes, her hair, the movement of her well-kept hands, her walk and manner of opening windows and closing doors, handling flowers and speaking to colleagues—each and all these things are noted and have their influence on the child. The conscientious teacher will, therefore, take herself in hand and prepare carefully by training herself to be as one whose "ways are ways of gentleness and all her paths are peace."

Responsibility Towards the Helper

One of the many duties falling to the teacher lies in the direction of training her helpers in the duties expected of them. This is essential for two reasons. Helpers are usually young girls who spend two or four years, 14–18 or 16–18, in the nursery school or class as a preparation for, or while waiting to enter, other work. They should be fruitful years coming as they do early in adolescence when old beliefs are being replaced by new doubts and idealism is on a rising tide. Many of the preoccupations of childhood present themselves in new form to the fourteen-year-old adolescent. There is the need of physical control brought about by a wave of bodily clumsiness that so often accompanies the onset of puberty. The transition to womanhood moreover brings with it the need for a new kind of social adjustment. At the same time there is a desire to understand and master the new problems of living of which their increasing bodily

and intellectual development makes them conscious.

The adolescent has another problem from which the child is spared—an awareness of her "self," her ego, which makes for self-consciousness on the one hand and bursts of conscientiousness on the other. Whereas the child asks, "Is it right?" the adolescent enquires, "Am I right?" She experiences a new desire for service—to use her powers for some wider purpose than her own interests. For the helper's own sake, as she crosses the threshold into womanhood, the years in the nursery schools should, if possible, help her to form an attitude towards both childhood and authority that are likely to bring poise and easy adjustment. Whether the young helper eventually becomes a teacher, a nurse, or a mother, she will certainly become a woman, and whatever her sphere of life, her equilibrium as an individual, inspired by tenderness and love, loyalty and devotion will be as important as common-sense in the care of her health, cleanliness and her personal appearance.

There are many advantages in having these young helpers. When good, they are like big sisters who can play with children in a way that is valuable in its difference from the more thoughtful play of an adult. If they are physically strong and energetic, they can save the teacher much wear and tear, but as they are young their hours should be short, and an adult woman's service should never be expected of them. The chief drawback of these helpers, is that they are unqualified, and it is almost impossible to avoid giving them some duties with and some responsibilities for the children. The teacher needs their assistance, however, and the contact with the children makes the helper's work living and real to them. Superintendents and group teachers should be able to guide their helpers in understanding more and more fully the nature and needs of the individual children in whose education they are co-operating, and something of the

physical and mental make-up of children generally. This task is as important as any falling to the staff, for without it much of their work with the children is bound to be undone. It so often happens that things the teacher has patiently trained the child to do day after day, are hurried over when the helper is given responsibility. This happens not because she is grudging of her service but, on the contrary, because she is so anxious to do what is expected of her and to win approval for the rapid accomplishment of her duties that the children are of secondary consideration. "Come and get washed," says a helper to a child with many pieces of his jigsaw puzzle still unplaced as he ponders over the shapes to be filled, adding, "Here! you'll never get that done in time," and hey presto! the puzzle is bundled into its box unfinished while the bewildered and resentful child is dragged to the toilet. Such situations as these arise constantly unless the daily routine makes the scramble that frequently exists unnecessary, or the helper understands something of the real purpose of nursery education and appreciates that her first loyalty must be to the children. One excellent helper was an ex-elementary school child who, years previously, had been a child in the same nursery school. When the superintendent was demonstrating with basin and towel how the helper should assist children with their toilet by letting them imitate her movements, the helper said, "You really do not need to show me this, Miss —— I was a child here once, and I don't think I have forgotten anything." Then she added in a grown-up manner, "That, of course, was before your time." The way in which this young girl "educated" the children whatever her duties was as great a testimony to the work of the previous superintendent as she could desire.

Weekly sessions, or a daily few minutes given to training the helper is time saved. Where the helpers are encouraged to keep simple records of individual

children, the observation that is involved and the necessity for keeping hands discreetly "off" is in itself a valuable form of training. Conferences held periodically to discuss these observations and the children whose doings they record are also useful. At such sessions, questions such as "What new playthings do you think he should have?" or "What do you think would be the best way of helping him to overcome this or that?" can be discussed. Other practical problems could be also considered in a way likely to reveal the deeper purpose that lies beneath such simple procedure as learning to use the toilet properly. Untrained helpers are now being replaced in many places by girls qualifying for the National Nurses Certificate and who undertake work in the nursery school as part of their training course. Concurrently with this practical experience they attend lectures and discussions on the care and training of children. The assistance of these girls should be most helpful in the nursery school and far better than that given by totally unqualified helpers. At the same time the experience should be of great value to the young student in her preparation as a nursery nurse.

Co-operation with Mothers

Nursery education, whether provided in schools or in classes, is intended to supplement the home and the nurture and care provided there. It can discharge this duty adequately only if there is close and friendly contact between home and school, and understanding and mutual respect between teacher and parents. Both have their contributions to give, and the child is served better where such a partnership exists than where either stands alone. The mother has the greatest and most lasting influence and to help her is often the best way of helping the child.

It is not easy to give suggestions as to the best way of establishing this contact without running the risk of becoming a typical "Aunt" of journalistic fame, who advises on how to make friends and keep lovers and many other intimate matters. Every one must be guided by her own feeling after careful consideration of the character of the mother to be approached. The first move must, as a rule, come from the teacher. Mothers are a little diffident, conscious of superficial differences of speech and education. It is for the teacher to show that fundamentally they are both interested in the same matter—Tommy or Mary—and that the parents' help is necessary if the school is to understand and serve the child well. The response of the parents is usually very real, when once they realize that the teacher is animated by genuine friendliness and not mere duty or patronage. She soon becomes a friend of the family, invited to a cup of tea and given all the information required—and more! Mothers accept nursery teachers even more easily than they do those of older children, because the mother does not associate the former with "teaching," and many of them stand in awe of the "superiority" of the teachers. The nursery teacher is, like themselves, concerned with washing, dressing, feeding and putting to bed, and as such is more nearly an equal. They not only tell of Tommy's food fads and Mary's bedtime tricks, but want details as to what the teacher does to combat these. The way is now clear for real co-operation between home and school. Before long it becomes possible to plan together and so to give the child the balanced regime he needs—food, sleep and play. The responsibility of the Nursery School does not end when the day is over. What happens to the child when he leaves for home is equally important and much good work is undone if the child is allowed to play in the street, to go late to the cinema or to be out of bed

till all hours. Thus as soon as possible opportunity should be made to discuss her child's whole day with every mother.

It is a wise move to invite parents, aunts and all members of the child's family to visit the school and to watch the children in their occupations, meals or sleep. They can sit quietly and look on as any other visitor does, and when a member of staff can spare time to explain this and draw attention to that, the whole procedure becomes more significant.

Few people can watch children busy at their play in the peaceful atmosphere of the nursery school without realizing afresh the beauty of children and their charm. Their quiet happiness singing as they play, their friendly overtures to one another, the orderly way in which they replace toys and their independence generally—awaken a new belief in the possibilities of these little ones. Mothers are particularly responsive for they, more than most women, have dreamed dreams and seen visions. A feature of the nursery regime that particularly impresses them is the way in which children are controlled without commands, scolds, threats or any appearance of authority which is replaced by just a friendly suggestion given in a matter-of-fact way to which children respond without question. They see children eating food that they refuse at home, putting themselves to bed without any fuss or discussion, washing and doing for themselves in a way they had never believed possible. They "ponder all these things in their hearts" and the reverence for children that this arouses should bring with it a high sense of the privilege and responsibility of motherhood.

Motherhood is the one vitally important profession for which women are untrained (and unpaid). Collaboration with mothers by the nursery school should follow on the beginning made in that direction at the maternity centre.

Informative talks, accompanied by discussion, can be the means of transforming the child's home-life and the life of the mother, too. Talks can include such subjects as how to budget so as to buy the most suitable food out of wages—First Aid—Care of sick children—Principles of discipline—Clothes—Occupations for a wet Sunday—the list is well-nigh inexhaustible and mothers are always ready to suggest subjects themselves. They delight, too, to hear children's stories and songs and to spend some time purely socially. For informal talks with individual mothers the records kept of her child by the staff will provide a good basis for much helpful discussion and for hearing the mother's point of view. These talks, to be really effective and to "get home," must be supplemented by visits to the nursery school to see the principle in practice. Demonstration carries conviction that it is not just talk! No nursery teacher should feel happy about the response of her mothers until those who are free to do so have made a habit of dropping in to watch for a while as often as they can. The lot of the working-class mother is a hard and often a lonely one, and the visits to school, with opportunities of meeting other parents and the feeling of genuine friendship with the teacher as well as the superintendent, are fully valued. Mothers can offer their services to the school in many ways such as bathing children, helping with cooking, washing, mending, etc., and whenever possible they should be accepted. It turns the nursery into "our" school and strengthens the sense of responsibility to co-operate with it in the care for the child out of school hours. Dr. Ralph Crowley, late Senior School Medical Officer of the Board of Education, once said that in his opinion collaboration with the mothers was as important a feature of the nursery school as work with the children. It is far-reaching, affecting not only a particular child but the whole family.

The work with the mothers is so important and so many-sided that if carried out fully it makes heavy demands on the teacher, too heavy in view of her already exacting day. On the whole the scale of staffing in nursery schools is very inadequate and it should be possible to supplement it by grants for adult education. If this were done the work of training helpers and other unqualified members of staff could be done much more thoroughly, and lecture courses and discussions for parents could be organized.

When free kindergartens for children of three years of age were introduced into Adelaide, South Australia, the mothers of the first one in Franklin Street were so appreciative of the improvement in their children that they began to spread the news to other districts. They concentrated on Bowden, a neighbouring district in which there was considerable poverty, and paid house to house visits. They volunteered to keep house for Bowden mothers, to enable them to spend the day in Franklin Street. As a consequence the mothers of these two places worked together and made out so strong a case for a kindergarten in Bowden that this was the place chosen for the second one. As a consequence of the education of mothers that has been a feature of the work there and of the keen interest taken by them, mothers are always represented on the managing committees of the schools.

When all mothers begin to think in terms of "our" child instead of "my" child and learn to combine with doctors, teachers and welfare workers in securing the best for all children, the democratic ideal inherent in the 1944 Education Act should be realized.

CHAPTER XIII

TEACHING AND TRAINING

The Purpose of Training

The first part of this book deals with the nature of the child's growth. Many illustrations have been given to show that the desire and the capacity for learning and for acquiring skill arise spontaneously from within the child at different stages, without help or influence from without.

Emphasis has been placed on the strength of the actual impulse, since this is what provides the impetus for growth, maturation and learning. It is not, however, the whole process and the part that the teacher has to play in teaching and training has already been touched upon in previous chapters. Knowledge, understanding and skill do not, after all, appear spontaneously nor full grown, as Pallas Athena from the forehead of Zeus! They have to be built up by the process of learning and experience "It is never permissible to ask of a function, Does this come from within or without, but rather how much of it comes from within and how much from without—for both these influences always share in its making, only varying in degree at different times. If inner development predominates we speak of ripening, if outer is more marked, we call it learning."[1]

Despite the fact that the child has an inner guide and moves spontaneously in the way of growth, no child is likely to develop satisfactorily if left entirely to nature, however wisely and well equipped his material environment. He needs the human assistance not only of other children, but of adults who can teach and train him by

[1] W. Stern: *Op. cit.*

guidance and suggestion in the task he is endeavouring to accomplish—that of becoming master of his impulses and of adapting himself to the demands of life. The purpose of training is, therefore, not to bring the child under the domination of adults, or to prepare him for any specific kind of behaviour or "conditioned response." It is to help him to develop all his powers to the full, to bring them into harmonious correspondence and to set him on the path towards the achievement of a free personality. The free man is one who is well-balanced and master of himself. Over development or under-development in any direction, whether mental, emotional or physical, acts like a tyrant that keeps a man enslaved and imprisoned. The need of learning and the place of teaching are both sometimes overlooked in the nursery school through the desire to leave the children free. This is however a short view for it is only the child who has acquired self-control who can be really free.

The Nature of Early Training

Having in mind the purpose of training, it is evident that the nature of training given in nursery years, when the child is susceptible and amenable requires careful thought. If over-emphasized, or of the wrong type, it may become a means of enslaving the child, rather than of helping him towards freedom, and may arrest growth at an infantile stage. "Habits forced upon the child by domination, or keeping him to set routine for years, rob him of a chance to be spontaneous. He becomes a machine and more closely resembles the institutional child. . . . He, thus, does not become an independent individual, absorbing experience, learning by mistakes and success to judge and think for himself. The road of progress towards constructive living is not open to him."[1]

[1] "Appraisement of the Child"—*Growth and Development.* (Report of the White House Conference on Child Health and Protection.) (D. Appleton Century Co.)

The young child is very amenable and a lover of routine, and in this fact lies one of the dangers of nursery education unless conducted by those who respect the human spirit. To " condition " children into submissive, docile acceptance of unthinking behaviour and routine that has no meaning to them and serves only to establish habits ; to have them shout or march, or perform other tricks at the word of command, is to do violence to these little ones.

Certain habits are important and should be trained early, primarily those concerned with the maintenance of the body in good health which leave the individual free to pursue wider interests. There should be regularity in such matters as eating, water-drinking, elimination and sleep. Acquiring a liking for suitable food and good habits of eating, mastication and breathing, as well as habits of personal cleanliness and washing before meals, should all be learned early. All these habits are important and can be inculcated by the regular routine of the nursery school to which children adapt themselves quickly.

Except for such habits as these, training should be concerned more with forming attitudes than with acquiring definite forms of behaviour. It would be unsuitable, for instance, to teach " good manners " at this age, though very important to cultivate an attitude of friendliness, love and sociability from which " good manners," even if not conventional ones, arise naturally. When the child has become readily sociable, which has been shown to be a gradual process—for the psychic life has its own rhythm of growth—he is ready to be trained in conventional phraseology and gesture. " Please " and " thank you " and all usual forms of courtesy should be used unfailingly by the adult in her dealings with the child and, instead of demanding these expressions she can often give the suggestion, " People like one to say ' Thank you ' "—

"It's polite to say please" . . . which should be quite as effective and produce results in time.

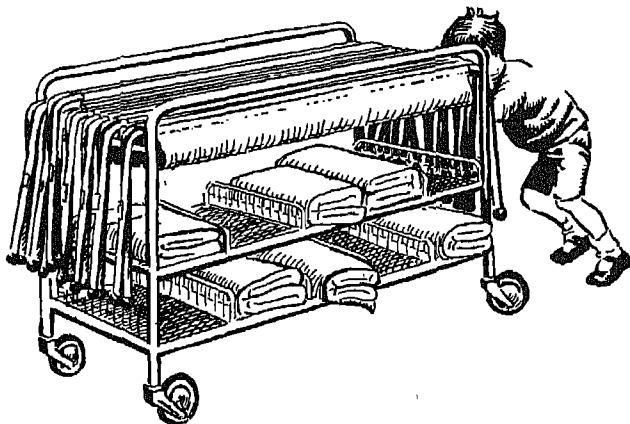
By four or thereabouts when children begin to be protective towards one another they adopt the manner of speech of the adults with whom they associate. If the teacher is always courteous in tone of voice as well as in words, her children will become the same, by imitation. Training in any kind of specific responses, given before they have meaning and purpose for the child, may have a stultifying effect on growth. "The over-taught child is father of the newspaper reading, advertisement believing, propaganda swallowing, demagogue-led men, who make modern democracy a farce."[1]

Attitudes of Self-reliance and Independence

What is chiefly necessary is for the child to acquire an attitude of self-reliance and independence, for this gives rise to many other valuable qualities that also become habitual, such as persistence, patience, resourcefulness and initiative. It can be induced by "so planning the environment and our procedure that a dynamic method of action will become habitual in the lives of our children. By dynamic method I mean a quality which we recognize and approve when we see it in action; a readiness to get to work on material at hand, a tendency to investigate and experiment in constructive ways and to sustain and develop this attitude."[2]

Children should have their own possessions, such as tooth and hair brushes, handkerchiefs, bed, blanket, etc., a place of their own in which to keep them and should be expected to fetch and use them when necessary. There should be a complete absence of any mechanical routine and formal procedure such as walking in line, holding on to one another's pinafores when moving

[1] Aldous Huxley: *Proper Studies*. (Chatto and Windus.)
[2] H. Johnson: *Children in the Nursery School.*

about, handkerchief " drill " at specific times. Children should be trained to self-reliant actions and expected to think for themselves and to solve the various situations that arise in daily life in terms of present need, and not as habit-trained custom. The daily arrangements should be

Bed and Blanket Trolley used in Bolton

planned to provide opportunities for self-help, such as removing furniture, setting tables, arranging flowers, fetching and replacing their own toys. The " time-table," if such skeleton-like framework as exists in a nursery school can be so called, should give ample time for children to carry on these occupations in a leisurely way, and for thinking out the various acts involved. Learning to change his own garments, fasten his shoes, etc., are occupations that have meaning and purpose to a child and afford training in manipulative skill as well as in independence. He gains real education from persisting in such tasks.

Though generally speaking the child should be encouraged to do things for himself, this can be overdone.

Nature's plan for human growth includes a long period of dependence, emotionally as well as physically. The child whose impulse is towards independence also desires adults to do things for and with him. It strengthens the bond of affection between them and helps the child to feel protected, loved and cared for.

FREEDOM THROUGH SELF-MASTERY

In trying to train children to be independent and self-reliant, the teacher has in the child a strong ally. Two to four years of age is characterized by this attitude and every normally developing child insists upon doing things unaided, and shows by his obstinacy and rebelliousness how eager he is to do so. The need of leaving children free to give full expression to their impulses and instincts has been very much insisted upon in modern education and it is important to recognize the difference between giving the child this kind of liberty and training him for freedom. They are not one and the same process and some of the ultra modern schools are doing a great disservice in abolishing all rules and regulations. " We are coming to realize more and more that the true freedom of the child is not objective but subjective freedom . . . if the child is to have true freedom for his personality he must learn control."[1]

Aldous Huxley echoes this opinion. " Here in passing it may be remarked that " modern " schools may be too " modern " by half. There is a danger that children may be given more freedom than they can profitably deal with, more responsibility than they desire or know how to take. To give children too much freedom or responsibility is to impose a strain which many of them find distressing and even exhausting."[2]

[1] J. A. Hadfield: *The Making of a Free Personality. New Era* September 1936.

[2] Aldous Huxley: *Ends and Means.*

Harriet Johnson, whose experience of nursery school education was obtained in a spirit of true research, was very emphatic on the need of limiting the freedom given in the nursery school to such aspects of the child's activities as he could reasonably use and benefit from. She says: "In evaluating any school set up and judging the children under it, it is very necessary to take into consideration the fact that the children's reactions are conditioned by the environment in which they are placed. This includes adults with their attitudes towards the children and the interest in their pursuits carried on even when the programme is not obviously in their control. In other words, environment and literally free activities are impossible and undesirable. In fact freedom, in the sense of lack of direction, would not be education. A group of little children assembled in an environment rich in constructive possibilities and left to their own resources would probably develop along the line of the weaknesses of its members and could surely not gain group continuity . . . It is obvious that no social organization could be evolved by such immature individuals. Our aim is to avoid dictation, to let the children learn by self-initiated experiences and experiments as long as it is within our control and whenever possible to allow this condition within the environment to furnish the corrective or stimulating impulses."[1]

Helping children to be free is a long process in which the teacher must use her authority wisely and well. She should keep as much as possible in the background but be always alert, observant and ready to come forward when the child is in need of guidance on some matter that he cannot settle by himself. The secret lies, as Hadfield shows, in helping the child to acquire self-mastery. Dr. Montessori follows a very definite technique in making children free. Through its adoption the children

[1] H. Johnson: *Op. cit.*

progress by way of activities involving self-control to a degree of poise and power that is unusual in young children.

The child has to build up this self-control and poise gradually. The first step is through the acquisition of muscular control and there are many ways in which this can be pursued in the nursery school. Free running, climbing, swinging, balancing, hanging, lifting and active play generally afford good training. Opportunity for such play should be so graded that four to five-year-olds are able to perform more difficult feats and exercise greater skill and control than are required of the child of two. This principle should be observed in the various domestic occupations in which children like to take part—setting tables, serving meals, sweeping crumbs—as well as in matters of personal hygiene.

Though the child should be under no compulsion to engage in these domestic occupations, should he desire to do so—as practically every child does—he should be definitely taught the correct way of handling the tools and utensils involved so that he may do so with dexterity. These occupations afford excellent training in muscular co-ordination and control which lead to grace and beauty of movement as well as to a heightened sense of order. If on the other hand, rough, careless handling is permitted, the result is only clumsiness and a low standard. The two-year-old who wants to help to set a table should be shown how to carry a tray in the proper way and his task might at first consist of carrying trays and piling them neatly on the waiters' table. Then he can learn to carry an object on a tray, a spoon, a cup or a plate, until eventually he is capable of carrying bowls of soup and jugs of milk swiftly without spilling them. There is no educative value in permitting a child who has not acquired the skill, to undertake any task beyond his powers, and to carry it out in an inefficient

way on which no comment can be made because it represents the child's standard. Whatever the activity, the child should be helped to build up skill by learning how to handle things correctly and by being given opportunity for increasingly difficult acts. The baby sweeping crumbs should have the pan held so that he can give his attention to watching the brush. Later he can perform the more skilful task of holding the brush in one hand and the pan in the other without all the crumbs going under the pan. Though when learning to feed themselves feeders can be given, children should be trained and expected to eat their meal without spilling and by three should be skilful enough not to require feeders. Dr. Montessori has shown the way all those actions can be taught by actual demonstration, the teacher having her own hand-washing bowl or tooth-brush or towel side by side with each child. "Do it like this—and now like this." Showing, reminding, helping should be done patiently, day after day until the habit is well established. Children do not learn by being told to do things but by repeating the action many times. This helpful demonstration should be given to children one by one. Attempts to take a short cut or get quick results by teaching children in groups is, at this age, time lost. Little children vary very much and each must learn to use his hands in ways that are most akin to his natural movements, which the teacher should study. The purpose of this detailed and exact training is obviously not only for this lesser object of carrying trays and using brooms in a special manner. It is to ensure for each child such co-ordination and control as will make him master of his muscles, to enable him to achieve success in the things he attempts, and to save him from the sense of frustration that comes when desire outruns the possibility of achievement. The child of five and over wants to do difficult things with his hands, making and handling real models.

By that age, if carefully trained to dexterous movements while co-ordination is being established, his hands are skilled tools at his command. This training would be unwise and dangerous if the nursery school did not also provide numerous opportunities for self-directed experimental manipulation and play.

Before giving a lesson the teacher should rehearse the act for herself and plan its moves so that it can be free from cumbersome fumbling and be both clear and efficient. She will probably be surprised to find how inexpert she is herself when tying a bow or emptying a bowl.

All domestic occupations are more valuable if performed on the child's own initiative. He should, by constant suggestion, be trained to be aware of their necessity and encouraged to rise to the occasion rather than to follow a mechanical routine of "duties." The nursery school provides its best education and training by establishing a way of life in which every day situations arising out of life, stimulate the child to purposeful activities. In the initial stages his attention has to be attracted and if necessary the activity suggested. "If you have all your toys would you close the cupboard ? it makes the room tidy" or "If you have finished with this would you put it back in its place ?—then you will know where to find it to-morrow." Again, "Water doesn't look nice on the floor, let us see if we can find a cloth to wipe it up." Then "Are your hands clean enough to use picture books or do you think you had better wash them first ?" After a time such suggestions become unnecessary. Children learn from one another and quickly fall into the habit of attentive observation and appropriate action. They are passing through a stage in which they are sensitive to order and orderly arrangement. This makes them receptive and responsive to training. In schools where this training is given,

children can often be seen closing doors without suggestion, straightening pictures, putting fresh water in vases, wiping it up when spilt with the same interest and satisfaction as they show in other forms of purposeful activity. Over-scrupulousness about cleanliness should, however, be avoided. Cleanliness is an adult conception to which children grow gradually, and undue early pressure of adult standards can be a cause of strain and conflict. This is true also of tidiness. So long as the child is at play untidiness of toys and material does not matter, concentration is more important. The play over, the child enjoys clearing up for himself.

Psychological Poise

The training that can be given in regard to emotional control and social adjustment has been dealt with in chapters on these subjects. Further comment is unnecessary except to stress again the importance of making the nursery school a place of joy in which children feel secure and loved. This the teacher can do partly by building a framework of ordered routine in which the child can feel free and safe and partly by preventing children from becoming over-excited, protecting them from their own weaknesses and from interfering unduly with others. When children have playthings that satisfy their changing needs, by four or thereabouts they begin to play with greater concentration and to attend more exclusively to the work in hand. This absorbed attention has a very integrating effect and as it becomes habitual a very noticeable change is apparent in the child's emotional and social behaviour, as well as in his standard of achievement. He becomes quieter, more serene, and seems to develop an inner glow of joy; he is more affectionate and considerate and eager to help other children. Whereas until now his play materials have been chosen rather indiscriminately and he has played

with them without long sustained purpose or goal, he begins to choose with forethought, giving evidence of working to a plan and remaining absorbed for a much longer period. He plays less for subjective satisfaction and more to attain an objective purpose. His play has in fact become work. He appears suddenly to "grow up" and both character and attitude assume definite form. This change has been likened by Dr. Montessori to the process of crystallization that takes place in a chemical in solution when the point of saturation is reached. All that was invisible, diffused and nebulous assumes a definite and often beautiful shape. From now onwards the child's "work" and conduct are on a much higher level. This "crystallization" of personality does not come about inevitably at this or any age, but is consequent upon the giving of absorbed attention to occupations that exactly correspond to some inner need.

TRAINING SHOULD KEEP PACE WITH MATURATION

Reference has already been made to sensitive periods at which the child is particularly responsive to education and training. To attempt to train a skill before the brain and nervous system are sufficiently developed for the child to be receptive to the particular teaching is wasteful of his time and nervous energy. This is true of training generally. For instance, no intelligent teacher discourages a child by pointing out his mistakes—if for example he has arranged graded bricks in wrong order in building a tower, through lack of sensory discrimination. She leaves him to his play, puts him within reach of such toys as will quicken his powers of observation, and waits until, as a result of exercise and continued development, he recognizes the different sizes of his cubes and builds correctly.

To give another example, it is harmful if not generally useless to try to train the child to be unselfish while he is still in the egocentric stage. Children who are forced to

share their toys or to play together before there is a natural impulse to do so, rarely become really sociable and unselfish, though they may adopt an outward appearance of these qualities to win adult approval. "Beware of over-estimating the ability of children to live easily up to our moral or personal standards or to understand adult customs. Because the child can talk and use some of our words, we think he can be made to feel as we do."[1]

Obedience

One of the commonest fallacies in regard to early education is that children should be trained to be obedient while young and plastic. Not only is the act of obeying one that requires a great deal more self-control than young children possess, but it is also a form of behaviour against which the child reacts with vigour when will-power is developing and obstinacy is at its height. The child must find himself and be in control of himself before he can obey. To make the child accept the ruling of others too early weakens the foundation of both moral and intellectual independence, and diverts the natural flow of energy from inner to external control. Such misuse of authority may bring about rebellion, or may, on the other hand make the child excessively suggestible and dependent.

The child's unwillingness to obey does not mean that he expects or wants the adult to abandon all control of him. Were she to do so, it would have a frightening effect upon him. "The impulse to accept guidance of the parent, or adult in loco parentis is deep-rooted and of biological significance. It is found in all mammals and the safety and protection of the young is bound up in the spontaneous reaction given to a firmly expressed parental wish. Every normal young child not only gives

[1] Susan Isaacs: *Health and Education in the Nursery.* (George Routledge and Sons, Ltd.)

obedience if requested in the right way and place, but actually expects it. It gives him a feeling of safety and security to know that he has a strong adult in charge, and in the framework of this protection he feels courageous in his own ventures."[1]

What is the right way and place? There can be no precise answer to this question, as the right way differs at different ages and stages of growth. An unwavering attitude of finality in dealing with all behaviour difficulties helps the child most when he is establishing a habitual attitude towards conduct. If he feels the adult to be wavering or if the same situation is treated in one manner on one day and differently on the next; if the child is alternately petted and scolded he cannot know what is expected of him. At the worst he develops an emotional attitude towards praise and blame and may resort to all sorts of tricks in order to avoid disapproval and gain approval, or to get his own way.

As a rule three years of age is not a time at which children are responsive to training in obedience. Obstinacy is at its highest peak, for it is the period of psychological weaning when the child's every impulse is directed towards independence. He wants to do things by and for himself and his disciplining should consist in giving him every opportunity to do so. In aiding him to be self-reliant and approving it, the teacher is laying the foundation for real obedience later by helping the child towards self-control. She is also training him to regard authority as a co-operative and protective influence to which, when the time is ripe he can respond with trust. Authority sensibly administered increases the child's faith and desire to obey and enables him to see it as impersonal. All true discipline should work with the natural flow of children's vitality, and should only

[1] Susan Isaacs: *Social Development in Young Children.* (George Routledge and Sons, Ltd.)

secondarily take the form of restraint or prohibition. It should give the child the opportunity of doing what his impulses are urging him to do, and not drive him to bottle up his energies until they explode with violence. "Discipline has a double effect, one is the elimination of undesirable modes of behaviour; the other is the encouragement and development of desirable modes of behaviour. Many parents (and teachers) see this relation ship to the child only in the terms of the first. They look upon their function as a somewhat negative one of securing obedience from the child rather than the positive one of developing desirable traits. Obedience in and for itself is of little value in adulthood. Those who can obey and do nothing more occupy relatively minor positions when compared with those in whom some measure of initiative, spontaneity and zeal for living has been maintained."[1]

Needless to say there should be no punishment in the nursery school. If the child is difficult, defiant or unresponsive to adults, the cause is to be found, as a rule, in the environment, or in unwise handling, either in the school or in the home. Organization has been spoken of elsewhere as a framework that gives security. It should never become a cage in which the child feels thwarted or restrained. A child who has opportunity to use his energy in satisfying ways is rarely naughty. It is when energy has no adequate outlet that explosions occur as steam will burst a kettle without a vent. The solution lies in altering the environment rather than in punishing the child.

Sometimes lapses into unsatisfactory behaviour are the result of want of skill or development which only training and growth can cure. Sometimes bad behaviour is caused by the teacher's attitude. If she does not really enjoy her work or love children, they very quickly

[1] John Anderson: *Happy Childhood.* (Appleton Century Company.)

sense this and feel insecure in her charge. Naughtiness is a defence mechanism with which they seek, subconsciously to protect themselves. They become less responsive and more defiant—anxious to separate themselves from those whom they do not trust. In none of these cases is punishment the remedy—for in none of these is the child at fault.

Stage in Developing Obedience

In training the child in obedience the earliest form of request should take the form of an invitation rather than a command. "Would you like?" or "Will you?" etc., and the child, given the option, should be free to accept or reject the offer. At two his interests are subjective and he will do as he is asked if it is agreeable to him, or if he is personally attached to the adult who makes the request. When the period of excessive obstinacy is over, requests can be expressed more positively, but they should still be more suggestive than commanding. "It would be helpful if you did," etc. Children who have been treated reasonably and given opportunity to gain self-control should by about four or five years of age be ready to acquiesce in such requests, though not necessarily on every occasion. It is not until the child is nearly six or thereabouts when more objective interests have evolved that he is ready to obey in the true sense of the word—that is, willing to accept and act upon another's wishes. By this age he should have reached the stage in his play of setting himself tasks. He obeys adults and does what he is asked with a feeling of pride, born of the power to achieve and to carry through a task. If he is not forced to obey before he is mature in this way the child will become willing and anxious to work with authority and not instinctively against it, as he is at two to three years of age.

When Obedience Should be Required

In all Nursery Schools and at home there are matters in which the child must be restrained and obedience required for his safety and well-being. Fewer restraints are required in the school than is usual in the average home where there is much that could be a source of danger to the child. The teacher should decide on the things a child should be expected to do or not to do without question, and those in which obedience is desirable but not essential. The number of things in the first category should be as few as possible. They should include such matters as rough play, aggressive behaviour towards other children, careless treatment of school things, use of knives or dangerous tools unless an adult is present, and positive requirements such as replacing toys after use; handling school property with care and washing hands before meals, lying quietly and not talking or playing at rest time. In such matters as these there should be no question of permitting the child to choose, and it should be taken for granted that he will obey. Requests relating to them must be given calmly and impersonally. They should be requested not " because I say " or " to please me," but because " children may not do this " or " everybody does that here " or " this is the proper use " or " we can't do so and so," etc. The fact that such commands are few in number and are obviously fair and just usually brings a response from children who are very sensible. The child who does not respond must be restrained if necessary. The dangerous article should be taken from him or he should be removed from the source of danger. If a temper-tantrum follows, it is wiser to postpone the discussion until he has recovered his equanimity. Then when peace is restored the reason for the prohibition can be given in some generalized statement such as " Children do not do these things " or " that is only for grown-ups,"

etc. It is better that no emphasis be placed on danger, but consistency is essential. Nothing can be worse for a child than an adult who wavers or who alternates between indulgence and severity. It makes him feel insecure and produces nervousness in various forms.

Apart from matters in which obedience is essential, there are others in which conformity, though desirable is not necessary, and these should not be insisted upon until the child himself recognizes the desirability. Everything to do with courtesy or a co-operative attitude towards others comes into this category. The suggestion should be given in a way that clearly expresses the desirability of the behaviour but which nevertheless leaves the child free to make his own decision. " It would be better to do this, do you not think so ? " or " Have you tried doing that," or " I think Tom would like this." Such suggestions give a positive lead to conduct, but are not dogmatic requests.

Ability to obey and work with others even to the extent of denying one's own wishes, represents a level of development and a poised personality not attainable in pre-school years. The elements out of which this power develops are, however, present then and can be strengthened. If strengthened by adult example and training, skilfully employed, the child may in time be able to comprehend and accept the true meaning of discipleship, as Tennyson expresses it in *In Memoriam :*

> " Our wills are ours, we know not how,
> Our wills are ours, to make them Thine."

CHAPTER XIV

DAILY ROUTINE

Descriptions of nursery schools have been so numerous that most people are to-day familiar with the daily occupations. The informality of it all, and the procedure that fills the day are suggestive of the home rather than the school. Children spend most of the day playing freely, with pauses for meals, sleep and visits to the toilet. There are no signals to begin this or end that; instead there is a gradual transition from one occupation to the next. Children sing as they play—they talk to one another and sometimes wander about looking at things and touching them; the aquarium holds attention for a time, then an electric-light-switch is examined or the turning of taps experimented with.

Yet simple as it is, beneath all must be a plan to keep the day well balanced between activity and rest, and to enable all to work smoothly. The plan of the day and the fixed routine followed should be somewhat similar to the bony skeleton of the body, both as regards the place it occupies and the function it serves. In a well-developed body the bones are well hidden, covered by living tissue that reflects the character of the person, in the way it surrounds and gives beauty to the proportions determined by the bones. The skeleton, too, is well articulated, in order to give flexibility and variety of movement to the body as a whole, as well as to each limb. The same general principle should apply to the daily programme in a nursery school. It should give the shape and proportion necessary, and yet be so supple and unobtrusive that each day becomes an expression of the spirit of the community as a whole. Where there is lack

of planning, not only is all formless and haphazard, but this absence of clear purpose causes a feeling of uncertainty among the staff and insecurity among the children which results in restlessness, and lack of unity. The body of a person who is deficient mentally shows the same want of cohesion and purposefulness. Where, on the other hand, all is planned down to the last half-hour of the day, it is like a body enclosed in steel armour which both restrains and hides the life within, so that the day becomes a mechanism, rather than a living organism expressing the changing needs of the community. One of the many disadvantages of an over-planned regime is that routine tends to become an end in itself and to dominate the situation. Machinery must always be kept in its proper place and treated as a tool that, by relieving man of mechanical drudgery, frees him for a more creative and vital expenditure of energy. The daily programme in the nursery school should leave the teacher free to give her time to be with the children, watching, helping, guiding them and ringing such changes in procedure as may become necessary. Her days should never degenerate into a round of getting things done to time!

The Need of Flexibility

The main characteristics of the programme should be the few fixtures that never vary in time or practice; general flexibility, and a balanced day of activity and rest. A readiness to modify procedure is necessary both to keep the school living and to prevent the establishment of a standardized day in nursery education as a whole. Any attempt to fix routine while the movement is growing would be equivalent to arresting it at an infantile stage. Unfortunately tendencies towards standardizing procedure are already appearing, even though different nursery schools and classes serve such different purposes when conducted in slum, in re-conditioned areas, new

housing estates, good working class or middle class districts. This is doubly unfortunate, as the nursery school movement is a new bid for sanity in education, and for making the school a living experience to all who are connected with it—teacher, parents, children. If routine and procedure are standardized and features once necessary are maintained after their usefulness has passed, or are introduced merely because they are used in other nursery schools and classes, the result will be the building of yet another cage in which the spirit of education will once again beat its wings in captivity before dying in despair. All hope of experiment or of genuine research would in that event be stillborn.

Handwashing

One of the features essential in some districts and in others where the school is newly opened and parents and children are still untrained, is handwashing and hair-brushing as the *first* duty of the day. But this and other aspects of hygiene are in danger of being made into a "stunt." Training in personal hygiene is a necessary part of early education, and in schools situated in districts where this is little appreciated or practised, a "clean up" is obviously indispensable before the child mixes with other children, or uses any school toys or apparatus. This is not, however, true of all districts and should not be true of any, when the nursery school is well established and the superintendent and mothers have become friends. Children should arrive with clean hands and faces and tidy hair, as is the custom in most schools. Yet handwashing and hair-tidying are frequently the first occupation expected of the children before going to play for which they are so eager, even when they show their clean hands with pride having been washed at home a few minutes earlier. Education should not train the children to follow routine, but to adapt themselves

intelligently to the needs of every situation, and this "stunt" of handwashing for all, is an insult to the intelligence of the child and is likely to discourage mothers from discharging their own responsibility. If this were the only occasion for training children to take an interest in cleanliness and become skilful in achieving it, the routine would have some justification. But as children must of necessity wash and tidy before meals, there is then always an opportunity for teaching them to do so properly, without maintaining a routine that mothers frequently regard as a reflection on their standard.

Morning Ring versus Free Beginning of Day

Another routine is the morning ring which is often used to commence the day's activities and introduce the free play period. It is a carry-over from the Froebel tradition whose main disadvantage is that it makes the children wait for school to commence, instead of getting busy on their own initiative the moment they arrive. When children are permitted to play about while waiting, either with or without toys, such play is abruptly interrupted when the hour for the ring strikes. There is, however, no reason why the day should begin with a collective period, and many why it should not do so. Children arrive eager for play, sometimes with very definite plans for it, and should be permitted to settle down as soon as possible. Play is their real education, and habits of industry are not acquired when there are periods of doing nothing but waiting. The early morning is a time of day when, more than at any other hour, children's needs are widely different. Healthy, vigorous children, those who have had good sleep in airy rooms, and proper breakfast are, as a rule, full of energy. Those who have been early awake, and possibly up and dressed, because of the general busyness in the home as each member of the family is got off to work, are apt to feel less vigorous in

mind and body. And the same is true of those who have had insufficient or restless sleep in crowded or stuffy rooms, or who have been hustled or upset in dressing and getting to school on time. Children often require time also to recover from the emotional stress aroused by nightmares common at this age. They play these feelings away if left alone.

When the teacher prefers to keep to the old custom of the morning ring to begin the day using it as a time for collective greeting, for hearing one another's news, singing hymns, saying " Thank you," etc., special activities that come to a natural end can be reserved to precede it—such as preparing the playroom—polishing door knobs, filling up flower vases, dusting, arranging toys, or the feeding and watering of pets, etc. It is unfortunate, however, if free play is long delayed.

An observant teacher will note how differently each child begins his day's play, and when he is free to follow his natural impulse throughout, to alternate strenuous work with times of pause. Some children choose difficult or strenuous pursuits first, and end their morning with restful activities. Others reverse the order, and sometimes begin the day by doing nothing and work up to their high peak. Stanley, a highly nervous child of four who was emotionally disturbed by quarrelling between his parents, usually did nothing for the first fifteen minutes or longer. Then he would as a rule choose an occupation that necessitated the exercise of considerable control, such as piling blocks into a tower and trying to carry them without upsetting the balance. If unsuccessful at first, he would persist until he succeeded, after which he would turn to other kinds of play. Many adults feel the value of beginning the day with a quiet time for self-collection that makes for inner peace and gives an opportunity to gather power for the day's requirements. Was Stanley intuitively having his quiet

time in order to harmonize himself and create a stillness among the warring elements within him? Throughout the day every child moves to a rhythm peculiar to his own needs and temperament. It is instructive to observe the succession of activities chosen and the amount of effort used, and to note the way in which a child balances his day between activity and rest, occasionally lying down to work, or rolling and kicking to restore the elasticity of the body after much standing or sitting at play. Sometimes in visiting a school one is surprised to see a child playing with toys that are usually the choice of younger children, or engaged in some occupation in which mechanical repetition alone is involved, such as peg board or bead threading. If one continues to watch it frequently becomes evident that this babyish occupation is a rest period either before or after a more exacting one, and that the child had probably resorted to it for much the same reason as a woman takes up her knitting, while things sort themselves out in her mind.

These naturally different rhythms, and in particular the varied type of play with which children begin the day, make it desirable to have the whole day as informal and unstereotyped as possible.

Collective Periods.

Organized play in which the teacher controls and directs affairs has its place in the nursery school day but it should be a small one. It is of value in giving children a rest from self-initiated pursuits, and affords experience of doing things together that is stimulating to social development. On the other hand such play makes demands on the children, requiring them to fix their attention, to obey directions, sit still and wait for their companions. This, though good up to a point, causes strain if the periods are lengthy ones. For two-year-olds a very few minutes of organized play is enough, and for

most children under five it should not last longer than fifteen to twenty minutes.

If there is real flexibility, the time and nature of the collective period will vary from day to day and at different seasons. On days when children are absorbed and happy in their own individual play it is unwise to break it, in order to have a collective period at a regular hour. It can always be introduced later, when the play comes to a natural end for a meal or other fixture. On some days it will be a very short period—perhaps two or three minutes—on other days it may be necessary for the teacher to be leader and instigator of activities. There are periods in every community when a spirit of unrest is abroad, when children do not settle happily to their play, but are easily upset and quarrelsome, or excited and boisterous, interrupting and interfering with one another. Occasionally these group moods are caused by the teacher herself who, though she may think she has left "the blues" outside, or is successfully suppressing her anxiety over some personal problem, is really a centre from which unrest spreads. Days of restlessness may on the contrary come from one or two lively spirits who dominate the situation.

When children appear to be growing weary of their free play or show signs of restlessness it is advisable to introduce some organized play in which they can look on the teacher as leader. Such play may involve the whole group or only a small section of it. The occupations most suitable for collective periods are music in the form of singing, rhythmic movement or percussion band, games, stories or nature talks. *Music* should feature largely in the daily programme and there should be a good musician on the staff of every nursery school. Children delight in music and should have ample opportunity for singing, dancing and rhythmical movement which has a harmonizing effect. Many

instruments belonging to a percussion band are available and even little children can use drums, clappers, cymbals, bells and tambourines. In addition to the favourite nursery rhymes, suggestions for suitable songs are contained in the bibliography. They should always be brief and deal with subjects familiar to children in a simple melody covering a not too wide scale without difficult intervals. Songs that involve action or finger play are always enjoyed.

Games should provide activity for all as well as turns for many, and should go with a swing. In reality it is games—not lessons—that give children genuine pleasure, especially those that provoke laughter. Games, and in fact all organized periods, should be free from that tedious "waiting" to get ready with "toes on the line" that rob them of their joyousness. When collective periods are dull or too long children find their own way of escape, either by little games of their own which interrupt the general one, or by indulging in undesirable habits and day-dreaming.

Stories: There are no good collections of stories for very young children. Such stories, however, exist, sometimes in collections of general tales and teachers are advised to make their own anthologies. The subject matter should be concerned with familiar everyday situations—people, animals, shopping expeditions, parties, etc. Reference has been made elsewhere to the value of stories in the building of a vocabulary. The right choice of words and good phrasing are in fact as important as the subject. In this connection interesting researches have been carried out and in the Report, the most popular stories are quoted in full.[1] Some of them are excellent in every respect—subject, language and arrangement. The story of the bunnies' tea party is one that every two-year-old will love and is an admirable illustration of the type of story suitable.

[1] Research of Mrs. Georgia Conant in *Studies in Pre-School Education*, published by the University of Iowa, 1938.

The change from free play to a collective period should be a transition rather than a sudden change. For example, when the teacher sees that the time has come to bring the individual play period to an end, she can begin to play the piano and sing, not as a signal but as a suggestion. Soon the children will put away their toys and gather around and a collective sing-song ensue. Or she can say "Do you want to go on playing alone, or shall we all play together?" or "Shall I tell you a story or would you like to dance?" Yet it should never be necessary for all children to cease play at the same moment. Those who prefer to remain at individual play should be free to do so.

Routine Visits to the Lavatory

When children first enter the nursery school, if they have not been trained to regularity or control, they and all two-year-olds should be taken to the lavatory at regular intervals. Because of the general dislocation that this causes—for the teacher should be there to train the children in the proper use of the lavatory, pulling of chain, and in self help—it is usually best for the group to go together. As soon as possible, however, this should be replaced by more individual treatment. Each child's natural elimination period should be noted, and after it is no longer necessary for him to be taken to the toilet, he should be reminded to go at regular intervals. Without causing strain, the length of time between visits should be gradually increased. After a time the child should be able to assume full responsibility in this matter, and go out when he needs to. This avoids the necessity of regimenting children and interrupting the work of all at regular periods. It also throws more responsibility on to the children and teaches them to think and plan for themselves. The helper, who should be instructed in the essential duties and appropriate attitude towards

them, or the teacher herself, should go off with any child who still needs help, and should also visit the lavatories from time to time to see that all is being properly kept. In a school with a large staff, it should be possible for all to take short periods of lavatory duty throughout the day, and be there to help any child who needs it.

ESSENTIAL FEATURE

There are several fixtures that should be unvarying, centres round which the day takes shape. These are: general inspection—for each child should be looked over on arrival—play, meals, sleep, toilet. The times of the meals and sleep should be fixed, and also the toilet visit that precedes and succeeds them, for such regularity is essential to good health. Playtime is more or less fixed, though as has been shown it can vary in nature and in length. This simple routine is that of living, not of schooling. The nursery school is an extension of the home life to which the child is accustomed, yet from the simplicity of its home-like fixtures it prepares the child and carries him naturally towards the wider experience that school life brings. The more home-like it can be made by the informality of its routine, the better. The daily time table works out somewhat as follows:

8.30 to 9 until 11.30 approx. Arrival, individual greeting and inspection of children—change to school garments, wash, tidy, use handkerchief (if necessary), have fruit juice, milk or drink of water. Play—no fixed time for individuals playing out of doors or in rooms as directed by their interests.

11.30 to 12. Putting away toys and getting ready for lunch. Those taking part in setting tables could leave their play earlier.

12 to 12.45. Lunch, followed by visit to lavatory.

1 to 2.30. Sleep.

2.30 to 3.15 (as children wake one by one). Fold blankets, visit lavatory, have drink of water and play.

3.15. Prepare for tea—after which change garments and get ready for home.

This time schedule for a whole day nursery school is also suitable in general principle for a nursery class, though some modification of the afternoon programme will be necessary if children do not remain for a midday meal and cannot get to bed at 1 o'clock as is desirable.

This arrangement divides the time available somewhat as follows:

Play. About 3 hours (a.m. 1½–2 hours, p.m. 1–1½ hrs.)
Meals. About 1½ hours. (Early milk or fruit juice—15 minutes. Midday meal—45 minutes. Tea—30 minutes.)
Rest. 1½ hours plus 15–20 minutes before lunch for 2–3-year-olds, if necessary.
Toilet. 1 hour.
Group activities—stories—percussion band—sing-song, games—approx. 20 minutes.

The largest amount of time possible should be allowed for play; play periods themselves should be long enough to ensure children becoming really absorbed in their pursuits. If they do not habitually do so, but instead play for only ten or twenty minutes between adult controlled activities, they do not develop the power of sustained attention or concentration. As a consequence, as they grow in body they remain infantile in mind and on entering the primary school are at a loss and unable to work thoughtfully.

A work atmosphere helps to encourage concentration and in the occupation period children should be expected when moving about and talking to one another to do so without unnecessary noise.

It is not specifically stated how much of the play period is to be spent in outdoor or indoor occupations, as it seems most natural for children to play where, and as they choose, passing from outdoor to indoor pursuits as their

play needs determine, and the school should be equipped to encourage play in the open air. It is artificial to have certain periods only for running about in the open air, and unreasonable only to provide for vigorous physical activity there. Children do not want only to run about out of doors. Such behaviour may satisfy puppies, but not children who want to do things and be purposeful in all their activities, and who are capable of establishing for themselves a balanced day of activity and rest. It is true that they do not always balance their day well when they first come to the nursery school. It is all so exciting, and there are so many new things to do, that they sometimes get over-stimulated and overtired. This danger must be guarded against and children who run about too actively or for long periods and get over-heated should be headed off to other pursuits. This restlessness does not as a rule last long. It is a symptom of psychic hunger, and disappears normally when the child's daily life and opportunities are satisfying to him.

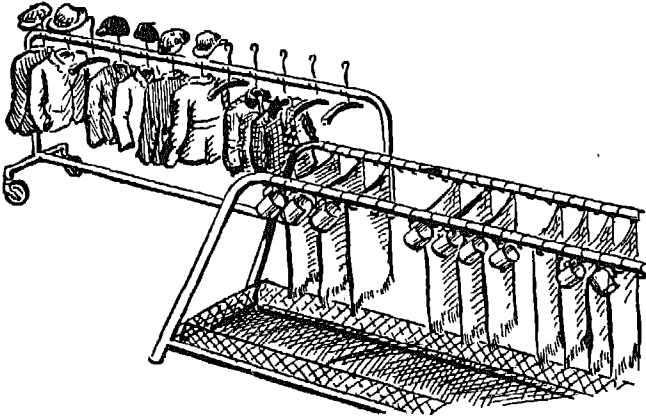
The outdoors should be as stimulating to all kinds of play as the playrooms, so as to enable the child to spend the bulk of the day there, when weather permits. Several things are essential to make this possible. The staff must be so organized as to have some teachers and helpers always out-of-doors and others in the shelters. There must be out-of-doors furniture, hardwood tables and something to sit on, both seats and waterproof ground sheets. Sheds, in which toys can be kept, are needed as well as places to play, and there should be suitable clothing to keep children warm. In summer the clothing question does not arise. In winter, it can be solved by the provision of suits like ski-suits, made of warm material that fit closely round ankles and neck with elastic and suitable damp-proof shoes. Such garments are habitually worn in American and are in use in some schools here. If they were provided in them all, children could habitually spend the bulk of the day out of doors in winter as well as in summer as they should do.

Preparing for Meals

In nursery schools where there is a midday meal and possibly tea, it seems inadvisable to take time for setting tables for the early morning milk or fruit juice. Children can fetch the bottle of milk and a straw and consume it while sitting watching others at play or it can be a buffet meal. When there is no midday meal, more of a feature should be made of the mid-morning meal. Tables should be set, by the children, with dainty cloths, plates for rusks and a vase of flowers. Good habits of eating and drinking, and the social training involved in nursery meals are important. In addition to regular meals and milk, there should be stated times for water drinking, in order that this good habit may be built up early. First thing in the morning and after sleep in the afternoon are both suitable times. If milk is served on arrival the water drinking can come later but it should be some time before the midday meal. The time appointed for milk-drinking is equally important. If the child has had a solid breakfast before coming to school milk should not be given before 10 o'clock. Otherwise digestion will be delayed. Unnecessary sitting waiting for meals should be avoided. It is better not to call children to table until the meal is ready to be served. Then a minute or two of stillness is all to the good and provides an opportunity for the "thank you," where this is said or sung. If there are plenty of waiters and servers, food is quickly brought to the children, and the meal is not unnecessarily prolonged. The use of forks as well as spoons is advisable for those over three, and pushers for younger ones. Feeders, though necessary for the two-year-olds, should be scorned by those of three and over, who should by then have learned to eat without messing themselves.

Time for Children to Play their Part in Routine

One of the advantages of a flexible time table, is the

opportunity it gives children to join in and play their part in all procedure; setting tables, washing and dressing themselves, folding blankets, and clearing up after their play. Where the day is planned in half-hour segments there is no time for this, as there is a constant feeling of rush on the part of the staff to get all done to schedule

Movable Apparatus used in Bolton

time. The nursery school has been well described by Miss Grace Owen as a way of life that is educative at every moment and place. It is so only if children are actively entering into all that happens there. This they cannot do adequately, if hurried and flurried, as they do not normally move quickly and fail to develop skill while trying to do so. When brushes are whisked out of slow fumbling hands by harassed helpers, and combs, towels and blankets are dealt with by adults at top speed, children fall back into infantile habits of being "done for." Education arising from experience of living thus becomes impossible and the nursery school ceases to be a place of education and is reduced to one for minding

children. Under these circumstances the value of it is very much diminished, not only for the children, but also for their parents who learn more about the way to train them by watching the self-help expected in the nursery school, than in any other way. Moreover, the need of a specially trained staff cannot be justified, where all is done for the children. Then any sensible woman could fill the post. Where, on the other hand, every occupation is an education in itself, in manual dexterity, self-reliance and in social helpfulness, children learn to live by living and the appointment of a suitably qualified staff is indispensable. It cannot be stressed too often that the child's best education is provided by adjusting himself intelligently to the demands of every-day happenings and exercising foresight and initiative in dealing with them.

Badly-planned Buildings Hinder Education

The desire to keep the day free from too great a number of set proceedings is rendered difficult when the building is either badly planned or congested, and garden space is not conveniently accessible. When many children have the use of only one room as playroom, dining-room, and sleeping-room, and where in addition a bathroom has to be shared with another group, it is extremely difficult to avoid set routine. When the weather is wet, or for any reason children cannot be out-of-doors, the problem of adapting a room full of children to a succession of uses is not an easy task. Once tables are arranged for lunch—or beds for sleep—there is no room for children to play, or to share in the arrangements. The teacher is confronted with a situation which tempts her to resort to arrangements that she knows to be of little or no value. Children are sometimes required to sit doing nothing while things are prepared for them. Sometimes they are given picture books, but having no tables on which to rest them, these

are not very easy to manage and are seldom a success. Picture books are too frequently used as stop gaps or as " comforters " to keep children quiet. It seems unfortunate that the child's first acquaintance with books should be associated with times of uncomfortable and tedious waiting, instead of delight.

It is not possible to give any precise advice as to the solving of these problems, which can only be dealt with satisfactorily on the spot. Where there is a spare room or hall or verandah as an overflow for children—or better still, where each room has a sleeping porch attached—which means two rooms for each group, these problems do not arise. Nursery classes in which children have to wash as well as eat, sleep and play, present even greater problems, though in most infant schools the big hall can be used as a play-place while rooms are converted. Someone has likened such unsatisfactory accommodation to one-room homes that are condemned by all. Nevertheless, resourceful teachers have triumphed over such difficulties. By means of such inventions as a double shelf—the top one used for play with small toys, or vases of flowers; the under one for storing basins, with towels hung beneath; or by screening off a "bathroom" corner, these " one-room schools " have often provided good training in skill and orderliness.

Arranging the Playroom

Rooms should be planned and arranged with care. They have a three-fold purpose, being places that generate purposeful activities and an educative way of life, that are aesthetically stimulating and that provide space and inspiration for many kinds of play. The usual rectangular room with its high walls and wide expanse of floor is not the sort of place that children would naturally choose for play. When free to do so, they invariably go to passages, cloakrooms, under the teacher's table and to

corners made by partitioning off a section of the room with furniture or anything else available. In the Haus der Kinder in Vienna the rooms were interesting in shape

A Blanket Store and Play Shelf combined in a Leeds Nursery Class

and the walls were broken by deep recesses and bays, each one of which was a centre for a specific kind of play. The play material was so attractively set out in

each place that the room gave the appearance of a well-planned garden, in which the children were as bees as they busied themselves first in one place then in another, seeking nourishment and delight. In another nursery school in the same city the furniture was specially designed so that it could be used for screening off corners and making play places. With a little ingenuity an ordinary playroom can be made more child-like by the provision of small collapsible clothes-horse screens covered appropriately, or the piano and cupboards so arranged as to provide playing places behind them. In this way special corners can be made for different activities. All the dolls, for instance, can be kept in one corner with filing cabinets for dolls' clothes, and furniture, prams and other accessories of doll-play. Another place might be the library with suitably constructed display shelves for books, dainty tables and comfortable chairs at which to use them. Waterplay or clay (if not provided for out of doors) can inhabit another corner with ground sheet on floor, and with the other materials useful for such play stored conveniently at hand.

If toys are sensibly classified and arranged in an orderly manner, wherever they are kept, and if dusters, brushes and pans, polishers, mops and all cleaning materials are also kept conveniently placed, and are in themselves attractive, children will form the habit of taking charge of their room and be constantly arranging and re-arranging, sorting and fixing. The furniture should be lightly constructed, not only to enable children to carry it about, but also to reveal every rough and clumsy gesture by being easily overturned. Montessori shows in the arrangement of her rooms how excellently furniture can be didactic and the means of training children to move gracefully. Her schools demonstrate that breakable cups and plates are more educative than those of an

unbreakable nature which can be dropped and knocked without the child becoming aware of his unskilfulness. Once, in lecturing, Montessori likened heavy, unbreakable equipment to the wiles of the devil that keep man unaware of his mistakes until he is so deeply involved that there is no escape for him!

The playroom can be made aesthetically stimulating in many ways and thus provide opportunity for the use of sensory discrimination that well-chosen apparatus should develop. Material for curtains, table-cloths, staff-smocks and overalls can be attractive in colour, pattern and texture. There are many dainty checked and striped materials that make very attractive table-cloths. Vases can be good in colour and shape and sufficient in number for children to choose them discriminately when arranging flowers. Large bowls for flowers provide good patches of colour, but children are equally delighted with the single bloom in a tiny vase—a daisy from the lawn—one sprig of speedwell or forget-me-not, clover and grass or a pansy. The beauty of each flower is fully appreciated when allowed to stand alone. In all probability children learn to love flowers more when they are so arranged than when they are massed in big vases. Many proprietary articles are now sold in very small glass or china receptacles which can be suitably converted by a coat of dull-finished enamel. Fawns and pastel shades are generally better for this purpose than bright colours which do not make good backgrounds for flowers. It is useful also for children to know and enjoy these delicate shades as well as the primary colours; they usually delight in them as much as in the tiny pots. Children can also learn to make their own pots in clay and these can be coloured after baking.

In one school known to the writer colour was introduced by the novel method of framing pieces of material of a beautiful tone and texture which were changed

repeatedly. Children watched with interest for the next colour and for the pleasure of matching things with it and in this way developed a strong colour sense. The same principle can be applied to pictures. Frames can be procured with adjustable backs so that a succession of pictures can be exhibited. This is better than a simultaneous display which is never changed.

Needless to say all furnishings, table-cloths, floors and everything used by or surrounding children should be kept scrupulously clean for aesthetic as well as for hygienic reasons. As children play much on the floor a supply of movable mats should be available. They take added care when the things they use are pretty, such as table-cloths, but when these get dirty or stained they become careless in table manners. For two-year-olds who are at the stage of learning to manage spoons, it is preferable to use material for cloths that can be sponged daily, and there are many quite attractive stuffs of this nature such as lancaster cloth. In addition to their aesthetic value, all these details of arrangement provide excellent opportunities for training in dexterity, good habits and a sense of order, to which children respond readily as the experiences have a meaning and a purpose that they can appreciate.

CHAPTER XV

GROUPING THE CHILDREN

THE TWO-YEAR-OLD

THE routine in the previous chapter, though suitable in a general way for children of three and over, does not meet the needs of the two-year-olds, for whom special provision must be made. At two the child is just emerging from babyhood and is in the stage of gaining control and getting firmly on his feet, physically and psychologically. In order to achieve this, experiment is necessary. The child is very active physically, climbing, jumping, balancing, and using his body in a great variety of ways. He is equally busy examining, investigating, poking fingers into everything and discovering all he can about things and people. As has been already explained, the impulse for free, independent, self-reliant activity, that rises so strongly, is accompanied by intense emotional dependence. The child is more loving and demanding of love than he has previously been and is particularly devoted to the adult with whom he has been most closely associated —mother, nurse, or teacher—and feels forsaken when separated from them. It is therefore a bad age to change nurses, and for the same reason, there are many who believe it to be an unsuitable age for the child to make his first attendance at the nursery school and be separated from his mother. When this happens, some fear that psychological violence is done to the child, though in the many homes in which separation occurs because the mother is breadwinner this criticism does not apply.

The Nursery School Can Help

It is generally considered advisable for the two-year-old to spend a shorter day in the nursery school than is customary for older ones, provided his mother is at home and is able to care for him. There is little doubt that for many, if not the majority of two-year-olds, the nursery school can meet the needs of the difficult transition period from babyhood to childhood more satisfactorily than the average home is able to do, provided, of course, that the two-year-old group is small and other conditions referred to later are observed. It is built round the child, being in very truth a children's land wherein opportunities are arranged that give an appropriate outlet for the exercise of both physical and psychological impulses that arise so insistently at this age. In the family it usually happens that either the child's impulses have to be suppressed in the interests of adult convenience and the child's own safety, or the adult world revolves round the child making him too much the centre and dominating all by his charm—or "naughtiness." To be too much with adults in an adult setting is disadvantageous, for the child receives over-much notice in the form of either encouragement or discouragement. In the nursery school this does not happen All is safe and suitable, and with a background of adult security, of which the child is fully conscious, he is left very much to his own pursuits and is never the centre of the scene. He can be as active physically as his body is urging him to be, handling, examining and carrying things about, and can find satisfaction for his eager intelligence without running any risk of harm. The number of situations in which he has to conform to adult wishes being relatively small, temper-tantrums, fits of obstinacy and rebellion are seldom aroused and the child is able to use all his natural assertiveness in gaining mastery of his world. It is by this

means that wilfulness grows into will power instead of finding expression in aggressive unsocial behaviour.

Special Arrangements. Entering the School

The nursery school can be of service to the two-year-old if special conditions are observed. The child takes a very big step when he leaves the intimacy of his small home inhabited by those he has learned to love and rely upon, and goes among strangers in a strange place. Everything is new—the building is unlike home, and he does not know his way about; the adults are unfamiliar, the other children are many in number as well as unknown. The shock of being suddenly and unexpectedly separated from home and mother can be very real and give the child a feeling of being forsaken. A day can seem like eternity, for the little child has no time sense and accepts things as for ever and ever. The pitiful, hopeless crying of a newly arrived two-year-old sometimes heard is an indication of the unhappiness and fear that some of them experience. In order to save him from this shock, arrangements should be made, wherever possible, for a gradual entry. He should have time to become acquainted with the building, the things that happen in it and the people with whom he is to be associated before being left for the whole day. The first step can take the form of a visit, or several visits with mother, or some well-known adult, during which they can sit and watch other children at play, and "look round" the cupboards, bathroom, the lavatory, kitchen, etc. Following that, the child can be left for a short spell—perhaps the play period only—and go home again at its conclusion. Then dinner-time can be included, by which time the child should be ready to face the full plunge, which he then takes with eagerness, as his interest is already awake. He feels safe, among friends; he has also learned his way

home on the many visits and as a rule settles down contentedly. Many a child who remains happy during play-time, becomes tearful at dinner-time and even more so at sleep-time. Meals and bedtime are so closely associated with home and mother that the plea " want me mum " is frequently heard. Sitting beside and having a bed near some known older child or in close proximity to a loving adult often comforts the child, and the presence of out-door clothes on a nearby chair " all ready to go home after bedtime " is reassuring. Parting with outdoor clothes is often an occasion for tears. It seems like severing the last link with the known and familiar. Where children are really anxious, it is often advisable to let them keep their hats and coats on until they begin to feel at home. They soon discard these hampering garments themselves as they settle down.

The Teacher and Size of the Group

The teacher of the two-year-olds should be carefully selected, for hers is the all-important role of mother substitute, someone to whom the child can turn in full assurance of love and protection. Unhurried in her movements, she should also be serene, patient, gentle and affectionate by nature. It is inadvisable for these little ones to be put in charge of the helper. They need individual care and training, for it is at this age that they must learn to use the lavatory, blow their noses, eat with spoons and become proficient in the various duties with which the day is filled. The teaching must be given day after day with patience and understanding, and every child encouraged to feel a growing sense of power and achievement. If habits of self-help in regard to personal hygiene are acquired at this age, the following years in the nursery school will provide possibilities for the child to pursue other and more developed activities. If, on the other hand, the little child has too much done for him, and

does not acquire good habits and skill, this deficiency will hamper him in successive years. Their need of individual lessons makes it also necessary to have the group into which they enter small, so that each child can have the guidance he requires. A group of six or eight children at most is essential for this and other reasons. Few two-year-olds have been associated with other children except their own brothers and sisters, and the initiation into a world of children will be less frightening and more successful if the number with whom they are first associated is limited. Apart from their dislike of having to share the adult with many others—which often arouses hostility at this age—children have not yet learned to adjust themselves to other children. They do not find it easy to do so at first, because, though attracted to children, they are inclined to relegate them to the category of " things " rather than people, and to try to dominate and use them for their own needs. This behaviour is consistent with the egocentricity of the two-year-old, and it is the cause of scraps and slaps between them. They learn to see the others' point of view and to accommodate themselves to it more satisfactorily by beginning in a group, small enough for them to get to know one another intimately, as individual people. Where there is a crowd the personal element is less apparent and progress in social adjustment is slower, and sometimes unhappiness is experienced. A small group also simplifies the toy supply. Children of this age have not learned to share and quarrelling for the possession of toys is apt to occur unless there are enough of the popular ones for all. Waiting or sharing, forced upon very young children by insufficiency of toys, engenders an unfriendly attitude and retards the growth of the desire to share that should be established by about the age of four. Lack of physical control often causes falls and bumps which may not be only painful but also cause a feeling of inferiority.

Such tumbles are more frequent when groups are large. It is important for children to be really in command of themselves and able to run without falling before they join a group. Otherwise, the inadequacy they are certain to experience, tends to encourage individual play instead of social adventure. For this reason the two-year-olds should not as a rule use the garden at the same time as older children who often become very boisterous out of doors, and rightly so, and this has an alarming effect. Given a carefully guarded and happy beginning the two-year-old is able in a very few weeks to join with others and enjoy their companionship.

The Daily Régime for Two-year-olds

The day's arrangements should differ in many respects from that suggested for older children. These two-year-olds are less used to taking charge of themselves and need shorter times for free play and more frequent periods with the adult. These periods need not be spent in formal collective play but in simple pursuits such as going for a walk in the garden, looking at pictures or having a little game with her. Their individual play is more successful if the teacher is at hand, and if she sits among them several will bring their toys and play close to her and possibly keep up a stream of conversation as a means of sustaining contact. Their need of more frequent visits to the toilet breaks into individual play and brings them constantly into contact with the teacher. These visits, which afford opportunity for training in self-help and muscular co-ordination, are as educative as any other occupation at this age and should never be hurried.

Grouping Children

There are different methods of grouping children who can be brought together either on an age basis or in "family" groups. In some nurseries the children of

two, three and four years of age are in separate groups. In others the children under three are in one group and those of three to five in parallel "family" groups. It is generally agreed that for most of the day it is better for those under three to be together in small numbers and the maximum number of fifteen has been specified by the Ministry of Education as the size of their group.[1] This is a great improvement on the arrangements that existed before the war, but it is questionable if the young two-year-old—away from mother for the first time—should be required to share the Nursery School teacher (his mother substitute) with fourteen other clamorous two-year-olds. Perhaps eventually it will be possible to restrict the number to six or eight for these very young children who have special needs that cannot be adequately met where one adult has many of them to care for.

Though the under-threes should have their separate group, it must be remembered that they very much enjoy to be included occasionally in a group of older children for a short time or a special occasion when the activities are such that all can share. A birthday party is such an occasion, or the arrival of a visitor in the form of someone's pussy or dog. Older children also enjoy to play with "the babies" and there should occasionally be an opportunity for them to care for the little ones. These older children "both boys and girls alike, apparently derive considerable pleasure from caressing and helping the babes. They want to kiss, hug and nurse them, and hold their hands. They also ask or elect to take care of them, offering help with their duties, fixing their feeders, etc. The older children seem to feel important and secure in their superior abilities and are drawn towards the little ones who give them the opportunity for favourable comparison and general self-expression. They feel them-

[1] Ministry of Education Circular 10, par. 6b. (H.M.S.O.)

selves in the envied position of parent and delight in acting accordingly—lifting babes about to the extreme discomfort of the latter. It is the older children who enjoy this, and adults often have to come to the help of the babies being too much mothered and having their liberties interfered with. The older child may be trying to please the baby. He is also getting great pleasure for himself."[1] Though children gain much by helping one another this must not be overdone. "The attitude of guardian or mentor is as devastating as that of infant or inferior, and older children as well as babies must be protected from a programme that makes demands upon them beyond their capacity for making that experience an integral part of the maturing process."[2]

There are several advantages in putting children of three to five in mixed groups, apart from the common sense arrangement of grouping them on the basis of normal family living. Where children of various ages are collected, toys and play materials can be more heterogeneous than where all are at the same stage of development. This makes for varied types of play, which creates a more educative environment for the group as a whole. Children see others busy over different occupations, and are stimulated by it. For practical reasons it is also an advantage, in that all the children are not wanting to use the same kind of toy. Their interests are more varied because their stages of development differ. Children rarely completely outgrow any play interest during the nursery school period, and the fours like to revert to old interests and play with toys that they enjoyed at a younger age, though as a rule they use them in a different way. They like, too, to play with younger children at times. Where the children are classified in accordance with age,

[1] K. Bridges: *Op. cit.*
[2] H. Johnson: *Children in the Nursery School.* (George Allen & Unwin Ltd.)

babyish toys are not as a rule to be found on the shelves of the four-year-old cupboards. This is unfortunate as children are thus deprived of a real freedom of choice and of play that gives the teacher an opportunity to see a child's emotional and intellectual difficulties by the way he chooses and uses more infantile toys.

Though it is valuable for fives to be able to revert to the play of the two-year-olds, it is not so suitable for the twos to play with five-year-old material, much of which is beyond their power of manipulation. They are not sufficiently mature to understand its real usefulness, and familiarity with it before they can enjoy it spoils its appeal for them at a later age, when, if they meet it for the first time, they are immediately attracted to it. Such toys as matador, pic-a-bric, etc., can be used successfully only by children who have developed a capacity to play purposefully with an idea in mind, and who have acquired a certain amount of manual dexterity. In the hands of the two-year-olds parts are lost and broken and the whole toy rendered useless for everyone else. Thus whereas the toy cupboards of children over three should include play material of all kinds, those of the two-year-olds should be stocked selectively.

Another advantage of the family group is that it protects children from the quite unsuitable practice of being promoted from group to group, and enables them to remain for two or three years with the same group of children and the same teacher. They get very attached to their playmates, their room, and their teacher, and it is possible that a good deal of the restlessness, frequently seen among children in schools in which promoting takes place, is due to the unsettlement that this causes. It may sometimes be an advantage to move a teacher from one group to another, especially if she is finding any child particularly difficult, or to remove the child to another group. Sometimes a child is difficult because of his

individual problems which may need specially skilful handling ; sometimes the difficulty arises from a temperamental clash between the teacher and child of which neither is aware, but which nevertheless raises a barrier between them. A child often ceases to be difficult with a teacher of a different temperament. Nevertheless, changes should be infrequent at this age, and it is a disadvantage for the child to change his room and playmates at the same time as he changes his teacher unless this is inevitable. It is, of course, an advantage for the child to get to know more than one teacher, and in a well-organized school in which the staff's duties are divided for playground, bathroom, lunch and sleep duty, this occurs normally.

Whatever the method of grouping, it is desirable to have interchange between the groups, so that children can develop a sense of belonging to a larger community than their own group. This can be done in many ways. For example, birthday girls and boys can invite friends from other groups to special parties or to play games, or things can be made by one group and presented to another, or toys lent or exchanged. Such interchange between the groups adds zest to life, widening the scope of it. It prevents routine from becoming monotonous while still keeping enough regularity to create a feeling among the children of being at home and safe. Such interchange between groups makes the nursery into one big family.

CHAPTER XVI

THE GARDEN

ANYONE whose childhood's playground was not a room but a garden and who cherishes vivid memories of happy play surrounded by colour and scent, of wind and sunshine will agree that the chief feature of the nursery school or class should be the garden. She would urge that children be allowed to spend the bulk of the day there whenever weather permits, and find in it such pastimes and playthings as have been the delight of children throughout the ages. Yet those responsible for building and maintaining nursery schools, though often lavish in expenditure on building, furniture and equipment, are, generally speaking, content if the out-of-doors section consists of an expanse of ground, with perhaps a few shrubs or garden beds, a sand-pit and jungle gym. There are of course some notable exceptions where progressive authorities have planned for both nursery classes as well as schools, gardens that are full of joy as well as of spaciousness. The garden is an environment that has considerable influence not only in promoting good health, but also in awakening aesthetic and intelligent interest in living things and in sowing seeds of reverence and wonder. Unfortunately it is not possible to bring the countryside with its peace and healing to the city child—the joy of cowslip balls, daisy chains, bluebell woods, bird-haunted. But much can be done by those who know and love nature to create a garden that will be a source of pleasure and profit. The suggestions below are given with the assurance that the teacher of young children will be a nature student and thus be able to fill in and complete this outline.

THE GARDEN AS A PLAYGROUND

From a health point of view, no building, however much open, is as valuable as life in the open, close to unpaved earth with its magnetism and vital energy, absorbed so quickly through hands and feet. If children are to be induced to spend the day in the garden, it must become a real play-place full of suggestiveness and enjoyment, and not merely a place to run about in or to air indoor toys for short periods. Carefully planned, the garden can provide play material that is in wholesome contrast to the artificial shop-made toys with which so much of the day is spent—toys made necessary by reason of the divorce from nature that town life brings. Though many firms are now making toys excellently suited to children's interests and developing powers, it is disappointing to find objects purchased that can and should be constructed by children on their own initiative, or by the teachers and children as the need arises. Activity of this kind involving inventiveness and practical ability is educative in the truest sense. Initiative and resourcefulness are given insufficient incentive when ready-made products suitable for one kind of use only are provided in place of suggestive material that can be put to a variety of uses. With a few planks, logs, barrels, boxes, stones and sticks, many playthings can be constructed. Children very much enjoy home-made toys, which they have helped to make, such as see-saws, balancing boards, jumping stands, spring boards, etc.

The garden provides opportunity for storing and using a variety of such material and at the same time produces much itself. It is usually possible to obtain sticks and stones, leaves, acorns, conkers, and beech-nuts. There is generally someone connected with, or interested in, the school who makes periodical visits to the country and the sea—who can be commissioned to bring supplies. It is

frequently possible also for country schools to undertake to send these objects to town schools. Children put them to a variety of uses, loading waggons with them, decorating sand castles, etc. Large heavy logs can be clambered upon and used as buses, trains, aëroplanes; smaller ones can be rolled about or carried by groups formed spontaneously for the task and enjoying the co-operative effort. Logs also make good seats and tables to play upon.

The garden becomes interesting for play when, in addition to ample space for free running, it includes places for hiding and for getting into, such as shrubberies, sheds or playhouses. Playhouses should be small, about four feet high with door and windows, and inside a table and a bench to serve as seat or playing place. If creepers are trained over it—such as quick-growing polyganum or honeysuckle—this helps to make it secret and private, full of spiders and caterpillars which delight children, though not adults who consequently do not intrude. Thus they become real children's places. Other secret corners can be made by erecting fences or garden screens covered with creeper. Winding paths with smooth surfaces along which carts, prams or bicycles can be steered are also much appreciated. These can wind round flower beds, or wooden tubs of growing plants where these are used to beautify and break up a dull asphalt playground. A grass bank for clambering up and rolling down—both excellent forms of exercise—a sunk garden or pit with steps to go up and down, also add to the garden's charm. Perhaps as useful as anything is a scrap heap. No child will play in a tidy garden if he has access to a rubbish heap, and in every garden big enough the teacher should contrive to have an odds-and-ends corner. It can include boards and planks, large and small stones, lumps of concrete, builders' bricks and tiles, wooden paving blocks, barrels, drums or other

rolling objects, ropes, boxes or any " fillable " receptacle and waste material of all kinds that is free from splinters, nails, breakable glass or rusting tin.

Benches and tables are necessary for children to play upon and stepping stones provide good exercise in balancing. A tree to climb is, of course, a great delight and more interesting than a jungle gym or ribstall. Most nursery schools are too young to have grown trees, but, it is hoped that suitable quick growers are being planted for the future, such as chestnut, lovely at all times of year. Trees, in addition to being good for climbing make a centre round which play can gather, attract birds, give shade and provide much play material—autumn leaves, twigs, bits of bark, etc. Incidentally a tree demonstrates the rhythm of the seasons very dramatically when, after standing stark for months, buds and then a shower of leaves come, passing through various shades of green to the rich and beautiful brown of autumn.

Grass is so lovely to roll on that one cannot imagine a garden without its green carpet, but a paved surface well-drained is indispensable in winter when the grass is sodden with rain. A paddling pool is also a delight and quite healthy if the water is frequently changed through a properly constructed outlet and no child with sores on hands and feet is allowed to enter it. A shallow portable pool can be installed at not very great expense.

The garden is the proper place for pets, the care of which brings so valuable a lesson. Bantam cock and hen which can bring up their chicks, tortoise, puppy, hedgehog, and if the run be large enough and suitable arrangements for week-end and holidays can be made—bunnies, guinea pigs and white mice. Pigeons, flying free, can be kept fairly easily and become very tame, coming to the child's hand for food, and every effort should be made to attract birds by hanging up strings of nuts and scattering breadcrumbs.

THE GARDEN A SOURCE OF SCIENTIFIC INTEREST

If children really live in the garden at a time when their perceptions are very keen, they notice and make friends with the many interesting things and creatures that inhabit it. They learn to recognize the different sounds made by wind as it blows through trees and bushes. They note the way in which the different flowers receive its caress—the campanula by ringing its bells, the coreopsis bowing and swaying gaily on its slender stalk, the snap-dragon prim and unbending, except for a trembling of its leaves. They also become sky-conscious, interested in clouds, the lights that come and go and the shadows on the ground. They investigate and learn to distinguish the different texture of leaves and their surfaces—the cool juicy leaves of the sedums, hairy tough comfrey, smooth nasturtium, rough sunflower. For scent they have also a keen appreciation—nepeta, marigold, snap-dragon, burgamot, as well as herbs that should always find a place, sage, thyme, mint, and parsley. In French nursery schools herb gardens are usually included and are known as *jardins d'experience*. Children quickly notice the varied shapes of flowers and leaves, the needle-like broom, star-shaped lupins, spear-like iris, ferny pyrethrums. They are all a source of delight to the little ones, who like to find as many different kinds as they can and in doing so become at home with a great variety of plants.

Children also never weary of watching the forming buds and opening flowers and enjoy popping the seed-pods to see the neat and beautiful way in which next year's seeds are packed. A marrow with its mother and father flowers and its case full of seeds is among the many plants that can be grown. The seeds can be dried and put away "till next year" and then set in pots from which the plants can be transplanted. Though the children will probably not remember from season to

season, if this and other similar proceedings are done each year they will begin to be aware of the regularity of nature's ways.

All children love small things and few flowers give so much pleasure as rock plants. A rock garden can be easily set up even on asphalt and inexpensively stocked. By raising plants above ground level children can look right into the tiny bells of the dwarf campanula and on the faces of heartsease and rock-roses. A rock garden also provides good picking for indoors. Aubretia, lobelia, arabis are all hardy growers and have a long flowering season. One sprig of each in a tiny vase will give pleasure. A child dearly loves to be promoted to cutting these dainty stalks and arranging them, and it affords good opportunity for training in care and love of living things and of not cutting or collecting more than can be used.

A wild garden is also desirable and even a few yards in an odd corner can be turned into a place of beauty and surprises with tall flowering grasses, clover, celandine, dandelions, bulbs, primroses and bluebells. It can be planted on the banks of a sunken pond for goldfish. This, well fenced to accord safety to children and to plants, can become a favourite spot to look down into—but not to enter.

Children make friends with the many useful and interesting creatures that inhabit the garden, ants busy in the grass, worms and woolly bears—" worms with fur coats on," as one child called them—snails, bees, spiders, moths, and soon discover the kind of plants different creatures favour. They talk much about these things, asking why, when and how, and thus build up a rich store of memories that serves as a basis for aesthetic and intellectual creativity. Nature tables supplemented by nature talks help to quicken interest and give added insight, partly because in this way things can be observed

more minutely and partly because each is isolated from the multitude of other stimuli that the garden provides. A magnifying glass (reading lens) on the aquarium table is useful for closer observation, but for practical reasons it is advisable to keep this tied to the table. To children a glass prism that reflects bands of coloured light is an alluring mystery.

Though children do not consciously notice the changes that come over the garden as the year advances they are subconsciously aware of them and in time learn to recognize the rhythm of the seasons and the way in which nature is always preparing for what is to come. They see her care for the future, not only in her exquisite methods of packing seeds, but also in her leaf-bud forming and other preparations that precede the winter sleep. Planning, preparing, safeguarding, protecting—on all sides this is revealed to those whose eyes are opening. It gives the feeling of safety and an awareness of a master Mind that shelters all in His keeping. It is such experiences which give rise to the belief that nothing is ever lost, that death itself is but a new beginning. As Rupert Brooke expressed it:

> " Safe though all safety lost, safe where men fall,
> And if these poor limbs die safest of all."

GARDENING

Children do not enjoy gardening as such, in the sense of planning, and waiting hopefully for things to happen. They want activity and quick results. Their time sense is very rudimentary, especially in regard to the future which they cannot easily imagine. Seed beds are watched anxiously for a day or so, but are as a rule forgotten long before germination. Nevertheless, at about four years old children like to own a garden which they can dig, surround with shells or pebbles and know to be their own. One or two plants suffice and these

should for preference be provided near their flowering time. Pansies, lobelia, marigolds, that soon flower and make a gay show, a few hardy perennials such as michaelmas daisies and plants that flower and seed freely and come again and again like forget-me-not and nasturtium, are a good background for such a garden. The year-long experience of the big garden has its influence slowly and subconsciously, for children like to help in doing things there such as driving in stakes for tying up, watering, cutting off seed-pods "for next year." If the teacher can spare time to work in the garden while the children are there, her activities are very educative, even though the children do not always appear to notice what is happening.

The Garden as a Source of Wonder and Delight

It is not easy to estimate the extent of the garden's influence. A boy from a very rough home once met the superintendent of his former nursery school that he had attended three or four years previously. "Are you taking the children to the country again?" he asked. "Yes—we go off next month—do you remember when you came?" asked the superintendent, thinking of the rides on the donkey, the feeding of ducks and chickens, romps in the hay at the farm where the holiday was spent, and also one memorable day at the sea. "Gee, yes," he replied. . . . "Do you remember that butterfly?" "The butterfly?" echoed the superintendent with surprise. "Oh, Miss—you haven't forgotten that butterfly, have you? Don't you remember when it came on to the lavender and stuck its wings up together?—you do remember, don't you?" he asked eagerly and anxiously. Of course she remembered. A butterfly with wings poised on a bed of lavender in a cottage garden. This had remained vivid and clear in the mind of the slum child for many years.

Suggestions for Nature Tables and Corners

Nature tables and corners, aquaria, vivaria, are all valuable ways of supplementing the interests aroused by the garden and of providing wider knowledge and closer observation than would otherwise come to the children. These indoor aids can never take the place of the garden, but they afford a very valuable way of isolating plants and creatures and of giving opportunity for continuous observations of the life cycles. If they are to serve their purpose well they should reveal something of the beauty, the order and the rhythm of the outer world and so quicken the child's sensitive awareness and send him in search of the many wonderful things that are happening in the out-of-doors world. It is simple and practical to follow the rhythm of the seasons and to make the corner illustrative of the atmosphere and events of each season by the general arrangement as well as by the particular specimens included.

A low, fairly large table or wide shelf serves well if placed where children can have free access to it in a good light. In addition it is useful to have an out-of-reach shelf—for adults—not for children—on which specimens can be kept that are good to look at but not to touch—such as autumn berries. Many of these berries are poisonous to a greater or less extent and should be kept out of reach and so placed that berries which fall collect on the high shelf. This shelf can be a means of creating atmosphere with its bowls of bright flowers, its branches of budding twigs or green leaves, for things can be massed upon it in a way that is not suitable for the nature tables themselves. The vivarium, of which the cover should not be lifted lest creatures escape, should also be out of reach though low enough to be looked at.

Material for the nature tables, if added to week by week, a little at a time, is usually enjoyed more fully than

if great quantities are produced at one time. Whereas the out-of-reach shelf should be reserved for the teachers' care, children should be permitted and encouraged to care for the nature tables under supervision. They should realize that all things need careful and special handling, which the teacher is ready to show them. Obviously much of the value of the nature corner will be lost if it is permitted to become dirty, untidy or unattractive—with faded flowers or stale water in vases.

Winter

In winter the nature shelf and corners should represent sleep; bareness, inactivity—the period of "biding their time" as J. Arthur Thomson puts it. Bare twigs that later show green shoots, bulbs that also give signs of growth should be included with sleeping seeds, acorns, horse chestnuts, sycamore keys—these latter arranged in bowls of dead leaves by which they are half covered. The vivarium,[1] which must be kept in a cool place, can contain snails asleep. The Roman snail, which seals itself up effectively, as well as the Common Helix, should both have a place. A vivarium with sleeping frogs and toads can also be kept from the autumn. In the aquarium, goldfish and small carp carry on life much as usual, but it is possible to have a sleeping aquarium in which dragonfly and other larvæ are hidden in the soil, to emerge later. A collection of sleeping butterflies and moths—chrysalids—can be kept on large pieces of bark or in boxes lined with leaves.

Spring

The converting of a winter into a spring corner is best done gradually, in the same way as nature changes woods and hedgerows, bringing delight by the first blossoming.

[1] For directions for setting up aquaria and vivaria see C. von Wyss' *Living Creatures* and *Teachings of Nature Study*. (A. and C. Black.)

To the nucleus of budding twigs already in the corner and showing signs of life others can be added that soon produce catkins in the warmth of the room—such as elder, poplar, willow, hazel and birch. Flowers can be added as they appear. If they are grown in bowls every stage can be watched and appreciated. Ordinary daisy roots and coltsfoot are both easy to obtain and very attractive. Roots of primroses or garden polyanthus give gay colour. Growing bulbs, acorns in glasses, and many buds that open quickly, such as lilac, elm, poplar, as well as the ever popular horse chestnuts can all find a place. Flowers that open indoors like flowering currant (Ribes) and almond are ethereal in their delicacy. The chrysalids should be watched constantly as sooner or later each one gives up its treasure and the moment of emergence is an experience not to be missed. The aquarium beings to stir—more plants—more snails. . . .

SUMMER

This season of abundance is easily represented and nature tables can be constantly varied with a succession of lovely bloom. Many children are able to bring contributions from their home gardens and allotments. The corner also provides an excellent opportunity for collecting all the many different kinds of leaves—differing from one another in colour, texture, shape and size, and for examining the different kinds of stalks as well as buds and flowers. The aquarium and vivarium are alive and a vigilant watch should be kept for the emergence of the dragon-fly and for the protection of newts which want to leave the water. The tadpoles have now become frogs and must be on land. They can be removed to the vivarium, into which minute insects—easily found in a boggy swamp—have been placed, though they should soon be liberated. A wormery is also a summer interest. This is simple to make and easy to keep. A narrow

glass tank should be filled with layers of good rich soil, a small amount of chalky soil and then a lighter soil. Leaves can be placed on the surface and the whole tank covered with a dark cloth or any material that can be easily removed. The soil should be slightly moistened and large earthworms introduced. The burrows can be seen against the glass and the mixing of soil witnessed. The older children are usually very much interested in the sudden movement of the worms in their burrows which takes place when the dark cover is lifted and the light comes into the tank.

Autumn

"Season of mist and mellow fruitfulness," as Keats calls it, gives great scope. The mellow fruitfulness can at least be portrayed indoors by means of hips and haws on the high shelf, by other fruit and berries, vegetables and nuts. Branches of autumn leaves, gold red and brown should blaze from the high shelf and smaller quantities on the nature tables serve as a reminder of the splendour of the autumn world. There should also be some showing next year's buds.

Fungi are abundant and beautiful but so many are poisonous that it is not wise to include them on nature tables for very young children. Nor are frogs and toads, which if they were put into the vivarium must now be released from it to feed and grow fat before hibernating, very suitable companions for children. They feed only on living things and it is not suitable for such young children to watch them gobbling the worms that have to be provided for these creatures in captivity.

SOME ATTRACTIVE AND HARDY TREES AND SHRUBS FOR THE NURSERY SCHOOL GARDEN

Almond : *Prunus Amygdalis.* Early flowering.
Lilac : *Syringa Wilsoni.*

Lilac: *Syringa alba grandiflora.*
Hawthorn: *Crataegus Oxya-cantha* (white).
Crataegus Coccinea plena (red).
Broom: *Cytisus praecox* (primrose colour).
Cytisus praecox alba (white).
Buddleia: *variabilis magnifica* (attracts butterflies).
globosa (attracts butterflies).
Bush Honeysuckle: *Weigelia.*
Bride flower: *Philadelphus.*
Flowering Currant: *Ribes Atrosanguineum.*
Ribes Aureum.
Guelder Rose: *Viburnum opulus sterile* (snow-balls).
Winter Sweet: *Chimonanthus fragrans.*
Dogwood: *Cornus alba.* Blood red stems (good near water.)
Prunus Pissardii. Crimson foliage—also early flowering (January–February.)
Maple: *Acer palmatus sanguineum.* Scarlet foliage.
Acer negundo variegata. Variegated silvery foliage.
Siberian crab apple: *Pyrus baccata.* Lovely flowering. Persistent scarlet fruit.
Cotoneaster microphulla. Scarlet persistent berries, evergreen foliage—does well against walls.
Berberis Darwinii. Persistent fruits.
Berberis aquifolium. Very hardy. Holly-like evergreen foliage. Orange flowers, plum-coloured fruits.
Forsythia. Masses of golden flowers in Spring.
Ceanothus (*Floribundus* is the hardiest.) Blue flowers in early Summer.)

CLIMBERS

Clematis: *Clematis Jackmani.*
Clematis montana.
Jasmine: *Jasminum officinale.* (Very fragrant.)
Jasminum nudiflorum.

Honeysuckle. *Lonicera belgia.*
Virginian Creeper. *Ampelopsis quinquefolia.*
Ampelopsis Veitchii (clinging.) (Colours well in Autumn.)
American Vine : *Vitis Coignetiae.*
Polyganum baldschuanicum. (Masses of white flowers.)
Rambler roses of varied sorts.

N.B.—Laburnum, Daphne Mezereum, and Privet should not be included as the fruits are poisonous.

Broom fruit and lupin seeds are also slightly poisonous but not dangerously so.

CHAPTER XVII

FIVE TO SEVEN YEARS OF AGE

In the foregoing chapters some indication has been given of the way in which life in the nursery school is planned to stimulate and nurture all-round growth and development. Where this is successfully done, the child reaches the leaving age of five years, healthy, vigorous and well grown. He has manual dexterity and can use tools skilfully. Physically, he is well co-ordinated and agile. Mentally, he is very wide awake, full of curiosity which he endeavours to satisfy, partly by a flow of questions, to which he requires clear, informative replies, but chiefly by his own effort in experiment and investigation. He is very adventurous, has both initiative and enterprise, and is not easily daunted by difficulties, for he has learned to concentrate on self-chosen tasks with strength of will and self-discipline, until he has accomplished what he sets out to achieve. He is able to plan what he intends to do before commencing it, revealing thereby a budding capacity for abstract thinking, and he can imagine, judge and make decisions. Socially, he has learned to associate in a friendly way with others, not only other children but also adults who are not mother or near relative, whom he is willing to trust. He has, in fact, learned to play his part as a member of a community with give and take, which implies both warmth of emotion and a degree of restraint of it that is so essential for healthy adjustment. Unselfconsciously and with enthusiasm, he is able to join with others in play, in song, in acting, and in all the many activities that arise from his active and fertile imagination.

When he goes to the infant school, unless it is working on modern, progressive lines which continue the methods of the nursery school, this active " learning by living " comes to an abrupt end. No longer is he a member of a community sharing his interests with his companions, stimulating and being stimulated by them as they join in co-operative adventure. On the contrary much of the day must he spend in sedentary occupations, most of which are planned and controlled by the teacher. Few of the occupations bear much relationship to natural interest. The three R's, in which the child at first is only mildly interested (if at all), are given central place and the maximum of time. Opportunity to do the many things the child is burning to be active about is given a very small share of it. In many schools it is permitted only on Friday afternoons ! Yet the child himself and his needs have not changed. He is still at a stage of development when he learns most successfully through activity, and very little by formal methods. His eagerness to play and use his hands in constructive activities is still keen, and in doing so he reveals a quickening intellectual interest and capacity for learning. Being more of a realist than in earlier years, with keener observation of things as they are, and more critical judgment of his efforts, he begins to measure, to study proportions and to examine his products with ever increasing desire for improvement. All such activities are educative in the fullest sense—not only because they are a natural way to approach the three R's, but especially as they are for the most part, carried out with other children, involving much discussion, planning and co-operation. The influence of community life in the formation of attitudes and character and in the shaping of personality cannot be sufficiently stressed. Yet such valuable education is reduced to the minimum or crowded out altogether when the child's activities are narrowed down to formal methods of learning to

read, write and do sums; activities that have neither meaning nor purpose in themselves to children since, when approached in this way, they do not arise out of living experience.

Why should this sociable, self-active education cease when the child goes to the primary school? Is not this custom a relic of long-discarded educational theory and belief that children must be taught and trained by adults, whereas it is known that given the right opportunity and suitable guidance they learn best by their own efforts in company with other children? As has been shown in earlier chapters the impulse to think, to learn, to acquire skill and to use the mind in all the ways characteristic of man, arises spontaneously in every child growing normally. This impulse is a *driving force* impelling the child forward in adventure and achievements, including the mastery of reading, writing and number when interest in these activities awakens. It is the teachers' task to nurture and aid this spontaneous energy, to give opportunity and outlet, encouragement and guidance and having cleared the way in this manner to give the child a clear field. Unsatisfactory as it is to the child to enter a formal infant school from a well-run nursery school, it is perhaps more disastrous to one making his first entry to education without this previous experience. Such a child misses the educative advantage of varied play in a social setting and is therefore seldom as developed and as "work mature" as one who has spent three years in a nursery school. If therefore he could find in the infant department an opportunity for play and experiment and for being self-active in the manner previously described, this would compensate to some extent for experience missed at an earlier age. Five-year-olds entering a progressive infant school without having been in a nursery school often show their need for these earlier play activities. It is no uncommon thing for them to play in ways

normally associated with three- and four-year-olds and to pass on to activities more suitable to their age only when they have satisfied themselves at the earlier level of performance. In schools where methods are formal or repressive, this opportunity is denied and children in consequence lose something essential to their harmonious development.

For many years there has been a growing conviction that this break of method at five is unsatisfactory, and that education should continue until seven or eight years of age and in the junior school on the same principles as are found in the nursery school. There seems to be no justification for maintaining two distinct types of school for children's first five years of education—between two and seven years of age—and it is believed that it would be better, from every point of view, for children to experience the all-round education of the nursery school throughout the growing years of early childhood.

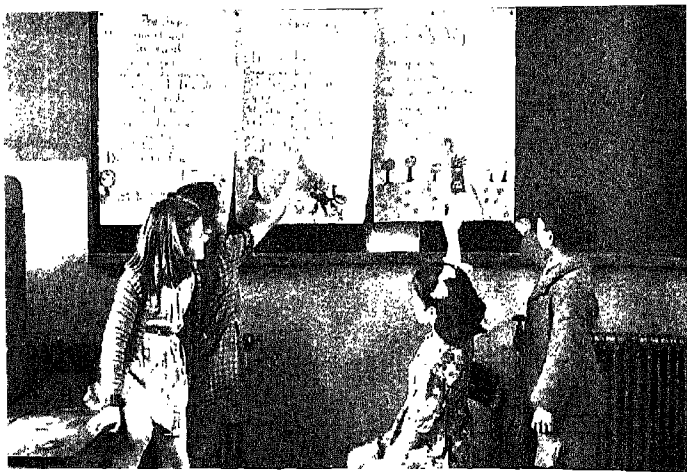
There is considerable evidence in support of the value of such continuity, for teachers in several infant schools and in some junior schools have been carrying on the experiment of conducting their schools on the principle of "learning by living." The results of these experiments are most encouraging. Teachers have witnessed a complete change in children's attitude towards learning, once the newer methods were introduced. What is equally encouraging, there has been a quickening of interest and enthusiasm not only on the part of the children, but also in the teachers as they abandoned the old-time custom of teaching a prescribed amount of this or that daily, and instead followed the children wherever they went, and entered fully into their creative living and learning. In her stimulating little book,[1] Elizabeth Taylor describes the change that came over her class when the newer active methods were introduced in these stirring words:

[1] *Experiments with a Backward Class.* (Methuen.)

"Everyone had, in fact, flung off the garment of ennui and indifference and were swimming blithely in a boisterous sea of purposeful activity." Similar discoveries had been made by all who have ventured courageously and planned intelligently for children's spontaneous interests. Many teachers have been particularly impressed by the extent of children's intelligence, their thirst for information and vivid memory when information is given in response to felt need and desire, and also the rapidity with which they have learned and acquired skill, including mastery of the three R's when these skills were attacked at the child's own time. Such experiments as have been made have revealed the many advantages of this method of learning, as well as some of the difficulties in connection with it that still await solution. They have, in fact, presented a serious argument for the creation of a new type of school for children between the ages of two and seven plus. Such a school would be growth centred and would provide progressively for the changing developmental needs and interests of growing children. In it there would be steady progress from the informal day of the two-year-old with its simple play, meals and sleep, to the more complex occupations of the seven-year-old. Throughout, the child would learn by actual experiment, which he would himself initiate and direct, helped and encouraged by teachers. Like the nursery school, it would be a school planned for a way of living, which would be educative in all places: rooms, hall, playground and garden.

In considering the planning of this school, the early stages would, of course, follow the pattern built up by the good nursery school. From the age of five onwards, many revolutionary changes would have to be made from the traditional infant school "set-up." As already suggested, it should be a place for full living—not narrow learning—with rooms for active occupations (carpentry, modelling, etc.), as well as the more sedentary work such

Seven-year-olds make toys for the nursery department

The toys are displayed with pride

Eight-year-olds discuss their own poetry

Children write and produce a play

as looking at books and reading, writing, hearing stories, poetry, music, and for meals. The régime of the school would be concerned with safeguarding and nurturing the growth of every individual child. First consideration would be given to physical health. Growth is very rapid between five and seven plus. It is the second " springing up " period which brings with it susceptibility to acute infections such as whooping-cough, measles, chicken-pox, all of which can, and often do, seriously undermine health. Because of this danger, as well as for educational reasons, children should not be congregated in large numbers in their classes. The buildings should be of an open-air type, and children should spend most of the day in active pursuits out of doors. The traditional infant school, in which children spend most of the day indoors in sedentary occupations with only occasional breaks for physical education or play-time, is totally unsuitable at this age. However, if, until new buildings become possible, work has to be carried on indoors, much can be done to keep rooms fresh and airy. The teacher should regard it of paramount importance to see to this and should so accustom herself to fresh air that she would quickly detect any tendency to stuffiness.

The introduction of nourishing meals and milk, now compulsory under the 1944 Act, is a wise and far-seeing provision, and should do much to raise standards of health and intelligence. It should also have a great influence on home standards where these are in need of being raised. It is very much hoped that teachers will never let " dinner at school " descend to a mere feeding-time, but will seize the opportunity it offers for training in good eating habits and liking for suitable food, as well as for social conduct. It is doubtful if there is any single feature in the nursery school that has done more to raise living standards in the home than the serving of meals and the cultivation of attitudes and habits that are

associated with them. The importance of this training must not be disregarded with the older children. They are becoming more conscious of behaviour, of social conduct, and are more actively responsive to the influence of daintily set tables and the social aspect of the meal, such as serving one another and good conversation. In resisting the many "extraneous" duties that in recent years have been imposed on teachers, that take time and energy which should be given to children's education, no infant teacher will, it is hoped, classify dinnertime as "extraneous." Good social and hygiene training is as important as learning to write, and it is the teacher's job to give it.

The meal, however, is only one aspect of the important training in social and hygienic attitude that falls to the teacher of these older children. Toilet training, so well commenced in nursery schools, must be carried on as it is possible to do in the newly-built infant schools, with their spacious handwashing rooms with hot and cold water, ample supply of clean towels, and indoor sanitation. Time should be made available every day for training children in hygienic habits and in arousing a social conscience regarding the care of these conveniences which others must share, however inadequate they may be. Children who have benefited from this training in their Nursery years experience a disturbing shock when they find these matters disregarded at school, and are in danger of associating cleanliness of person and of places as something babyish to be outgrown and forgotten. The day of having W.C.s across the playground where it is not easy to give training or supervision, and of dingy cloakrooms without soap or clean towel is past. Such out-of-date arrangements should be speedily replaced. It is useless to plan for a really democratic society, and at the same time to disregard this most fundamental aspect of education. It is the teachers

who must see that this training is given to every child. To achieve this successfully calls for smaller classes, and also the need for augmenting the staffing by the appointment of "helpers," as in the nursery school, for at least the children under six years of age.

Turning from such matters as physical care and health training to other aspects of development, it would seem wise to continue methods of learning by means of vital experience and activity. The child of five or six is as eager for movement, experiment and investigation as the four-year-old, and he learns best in this way. The appearance of the progressive infant school is not of neat rows of still and silent children, but is not unlike a beehive in which there is incessant going and coming against a background of buzzing chatter as they plan and discuss their occupations. Perhaps a workshop would be a better comparison, for children are to be seen engaged in all manner of pursuits—hammering, sawing, painting, cutting up materials, building, sewing, playing at shops and hospitals, at houses and railways, writing, calculating, and making every kind of property with which to assist the reality of their occupation. "A boisterous sea of purposeful activity." What a true picture this phrase gives. Of the value of such purposeful activity much can be said, and has been said so well and so fully that the student cannot do better than study the books on the subject listed in the bibliography. In these books details are given as to how to set about developing education on these lines, what to use and when and how to use it. From such books, too, it is possible to discover how much more children learn by these activity methods than from the more formal methods; how much they develop in leadership, initiative and in self-reliance; in capacity to carry a plan through to its completion, disciplining themselves as their work demands. How skilful and agile they become in move-

ment and in manipulation and how eagerly they seek information and guidance, as though hungry for knowledge and understanding! Perhaps the most significant result of these methods is the relationship that springs up between children and their teachers, and with other children. This building up of personal relationships is of inestimable value in the shaping of emotional stability, and comes about very naturally and easily in an active régime that throws people together in all kinds of unexpected, and informal situations. By the teacher's participation in everything that each child does, there grows up a sense of comradeship between teacher and child that draws them near together. The child who feels secure in the affectionate regard and active interest of the teacher becomes more confident, more adventurous, in all he does. With this happy relationship of trust and fellowship, he more readily accepts such suggestions and guidance as have to be given from time to time, and he turns to the adult spontaneously for help, knowing she will not fail him. It is an association that is stimulating to the child both emotionally and intellectually, and makes for sound educational influence which long outlasts school days.

Being brought into active experience with other children is also of the greatest value. The importance of social development has been discussed in an earlier chapter in general terms and also in relation to younger children. It is of particular significance at the age now under discussion, when children begin to form more or less permanent groups for their play and to have special friends. For them it is essential for school to be a democratic community in which they can play their part. In giving it their loyalty and allegiance, they begin to change from the egocentricity of early childhood into socialized persons. Children can be seen in their groups planning projects that continue day after day, overflowing

from classroom to corridors and main hall, and involving in good team work the co-operation of many children, each one with his own special contribution to make.

The fact that much of the day is spent in activities of the children's own choosing, does not remove the necessity for, nor the enjoyment of, collective activities planned by the teacher for the whole class. Not only do children delight in such work if not overdone, but there are many activities that cannot conveniently be arranged in other ways. Thus during each week there should be much music—singing, rhythmics, dancing and listening to music. There should be stories told or read aloud and lengthened, as children can sustain interest for many days, until long stories can be chosen. There will be narratives of many kinds—adventure, animal, children of other lands, and the traditional stories that never grow old. Poetry, too, should be read—the same poems read again and again till children join in bit by bit and then find they know them by heart. There should be acting and miming, gardening and pet-keeping, and, of course, games and physical education.

There are teachers who, though attracted by these newer methods, are, nevertheless, afraid to leave the traditional set time-table and formal teaching lest, as a consequence, the children do not make the progress in the three R's that is required of them. Miss D. E. M. Gardner's impartial investigations[1] should allay such fears. For though it is true that in adopting these methods children do not, as a rule, take much interest in the three R's at as early an age as they are habitually taught, it is, nevertheless, true that by seven plus they are as accomplished, and in many cases much more proficient, in them than is usual. What is of greater significance is the fact that the child is *really interested* in these skills which, approached when they need them, have

[1] *Testing Results in the Infant School.* (Methuen.)

meaning and purpose. This is not always true of children who have been kept laboriously at these subjects from the age of school entry when, as has been shown, there is little real interest in them. Writing is a difficult skill to acquire, and before it can be properly mastered the child must build up an eye-brain-hand co-ordination that enables him to copy what he sees. Before this is established, letters are frequently written upside down or backwards, and without proportion one to the other. Dr. Montessori demonstrated how in her schools (where this co-ordination was built up by a carefully planned régime of manipulation and also by deliberately cultivated sensory discrimination), children who "exploded into writing," as she claimed was general, wrote with well-formed letters from the first attempt. Dr. Montessori provided didactic material to be used in a very precise way to ensure this, which few teachers would willingly require of children to-day. But it is possible, without accepting her actual method, to follow the principle on which it was based—which bears close relationship to children's developmental capacity. The development of this sensory muscular co-ordination can be achieved by means of the varied occupations and play that characterize the spontaneous activity of children when adequate play material is available. If, therefore, by postponing the time for beginning writing and letting children develop themselves, the actual accomplishment is rendered both better and easier at a later age, and if there is also at this later age a keen desire for achievement because writing has meaning for the child—surely the delay is worth risking?

Reading, too, requires preparation if it is to proceed smoothly and bring with it the joy with which it should always be associated. For this accomplishment, as for writing, trained perception is needed if the child is to distinguish between letters that look somewhat similar,

such as b and d, m and n, c and e, or that sound much the same, except where hearing is acute, such as b and p, t and c. Another essential pre-requisite of intelligent reading is the possession of a good vocabulary and learning to speak well and fluently should precede the study of the written word. How much easier all reading is to the reader who is conversant with the words read. Then reading is full of meaning and of interest from the beginning. Nothing leads more rapidly to keen observation and to the formation of a good vocabulary than the adventurous and joyous form of education described, in which children examine, experiment and play with many things and also talk much with teachers and one another, and are ever asking for new words with which to describe the activities in which they are so eagerly engaged or anxious to pursue. The old standard by which a child's progress was rated by ability to read " Reader " 1, 2 or 3, must give place to a more intelligent assessment. The earliest stage of reading must, of course, be closely related to daily experiences or to action—reading and " doing." By the time children are able to read books, they should do so for the story contained. Thus approached, reading is always an intelligent activity and full of meaning to the child, who recognizes books as a magic key opening up a wondrous world. Book corners should be a feature of every infants' room (unless there are rooms specially reserved for reading). Here there should be publications suitable for all stages of learning, including good picture books and volumes that are a joy to handle, and rich in content. A good way to begin such a corner is, when " requisitioning," to ask for, say, three copies each of sixteen different "Readers" or story books, instead of forty-eight " Readers " No. 1, 2 or 3. To this nucleus of sixteen different books, other single volumes can be added gradually. The teacher can lend from her own stock

(which every infants' teacher should possess), when children have learned to handle books with care—or as a means of giving this training. Also she should encourage children to lend books which many of them have at home. In this way, real interest in books can be built up.

Number should be very practical in its early stages, counting, measuring, weighing, calculating "change" in shopping games, and should be, like writing, related to the activities in which the children are engaged. Home-made apparatus that can be so related is best in the early stage in all work in all three R's, but as children evoke interest in these skills, as soon happens, there is much useful material to be purchased for practice work.

The question as to whether it is better to keep the children under five in a separate school is one with much to be said for it. If a combined school is planned to cover the whole age range of two to seven plus, it will be necessary to protect the younger children from the disturbing and harmful effect of large numbers—and also to protect the older children from having their activities hampered by the presence of the slow-moving three- or four-year-old. The playrooms of the "under-fives" should be self-contained and adjoin both their lavatories and playgrounds, as has been discussed earlier, and these quarters should be so situated that they are not overrun by the older children who are too boisterous and quick-moving for the little ones. This does not mean that there should be no coming or going between children of different ages. On the contrary, the educational significance of these contacts is one of the valuable features of the school envisaged. It is so good for older children to visit younger brothers, sisters or friends, and for family groups to play together and gives them a keen sense of responsibility towards other members of the community. But it is clear that these visits need to be properly con-

trolled and limited. The needs of each age group are so different that their activities can only be of full value if carried on in an appropriate setting and with play material suited to their age. Nevertheless, each day would provide some opportunity for children of different ages to meet and enjoy one another, and for the whole school to form a community in which life would be for everyone, teachers and children alike, a joyous enterprise, to which they can give themselves wholeheartedly. But whether children spend these first five years of schooling in one school—or in two—it is firmly believed that the methods adopted in both should be similar so that children can progress in their education as naturally as they grow, from the interests and pursuits of the two-year-old to the ventures and learning of the seven-year-old. Is this a dream or is there not very real hope that the teachers of to-morrow will be inspired by what pioneers like Miss Boyce and others have already achieved, and will not rest until every infant school has " come alive " ; until all have broken with restrictive and deadening routine, repressive formalism and rigid time-tables, and have become real worlds—in which children can live in the full use of all their powers of head, heart and hand ? When this has been achieved, every child will be enabled to approach boyhood and youth as well do the requirements of junior and secondary school with stability, strength and intelligence.

MATERIAL OF ALL KINDS FOR CARRYING ON PROJECTS AND FREE PLAY WITH FIVE- TO SEVEN-YEAR-OLDS

Paper : Kitchen or unprinted newspaper. Crêpe paper. Tissue paper. Mounting paper—large and small sheets, different colours, gummed and ungummed coloured paper ; big sheets, squares and assorted shapes.

Cardboard: Thick and thin, white and coloured; corrugated.

Paints: Powder colour. Hogs-hair brushes, all sizes.

Crayons: Ordinary; thick, waxed for younger children.

Pencils: Ordinary. Coloured. Short, thick, for younger children. Some carpenter's pencils.

Scissors, paste, glue.

Modelling materials: Clay, boards or trays or covers for tables. Tools. Children's aprons. Plasticine in different colours. Dough—sweepings from bakery if obtainable.

House-play: (*a*) Wendy house or screens or clothes-horses, or large blocks or timber for making houses. Equipment for use in them; furniture, crockery, washing, baking and cleaning sets; dolls. (*b*) Doll's house—furnished for younger children. Materials with which to furnish it.

Shops: Materials (tables, desks or boxes) for making them, and for furnishing them. Balances, scales and weights, capacity measures, yardsticks, tape-measures, clocks with movable hands, cardboard coins.

Bricks: Various sizes and shapes. Boxes, odd pieces of wood, small planks, bobbins and spools.

Woodwork: Bench (or box or old table), wood, hammers, saws (hacksaws and tenonsaws), files, pliers, nails with large heads, sandpaper.

Oddments box: Odd pieces of wood and cardboard boxes of all shapes and sizes; bobbins, spools, corks, tops of jars and bottles, etc.

Number games, e.g. dominoes, lotto, quoits, bagatelle, skil-pail; shopping and banking games, and any others.

Sets of houses, cars, traffic signals, transport sets, train sets, farm sets—for use with bricks or making models.

Books: Story and poetry for children's use. Books dealing with everyday things, e.g. books of trains, aeroplanes, farms; story books of houses, clothes, etc. Books for reference: to find out how things work; to find out how to make things. Materials for making own books, individual and groups.

Book corners (*see* Bibliographies).

Physical education apparatus: Balls, varying sizes, including big rubber ones; hoops, bats, ropes, jumping stands, bean bags, balance bars, wall bars, ladders, ropes for climbing, individual mats, grooved skittles, canes (varying lengths), bands.

APPENDIX

OBSERVATION OF YOUNG CHILDREN

It is not intended in this appendix to present a comprehensive scheme for detailed observation, nor for assessing the standard of behaviour at different ages. Its purpose is to provide a form sufficiently brief to be practical for regular use in nursery schools and classes, yet comprehensive enough to enable the teacher to watch the growth of each child. However busy, her first responsibility is to foster the all-round growth of every child, and this is possible only by careful observation of every aspect of behaviour and noting its trend and progress.

The extent to which the child functions soundly—that is to say, uses his capacity to the full, depends partly on his attitude to himself and partly on the opportunity afforded by his environment. When he is functioning fully he will be alert and happy, will make effort, develop in intelligence, resourcefulness, independence, sociability and general stability. The nature of the child's play and his general behaviour are indicative of growth trends, and observations recorded over a period of time should enable the teacher to know if these trends are satisfactory. She should then be aware whether the child needs the help that she can give by personal approach, or whether a modification of the environment is desirable. She should also be able to realize when the help of a specialist must be sought.

It is vital to note the child's readiness to respond to the demands of reality or his tendency to escape into a world of his own. When development is normal fantasy play and egocentric interests should be gradually replaced by an increasing interest in reality and sociability.

It is suggested that for children under four years of age, entries be made each month. For children over that age, every three months should suffice. The method of recording suggested has been devised to avoid the necessity for much writing and to enable the teacher to see progress at a glance.

Some guidance is necessary as to the method of recording observations on the form attached. Functioning in which the child should gradually become successful should be marked —, — +, or + according as whether the child fails, is partially successful or is completely successful.

For example:

	Date and mark Oct. 25	Date and mark Nov. 23	Date and mark Dec. 21
Bladder control	—	— +	+

Such items are given the index figure (1) on accompanying form. Progress is shown by the appearance of + mark.

There are other items in which development consists not in success or failure but in the emergence of capacity or control—as for instance when the child begins to make sustained effort. An example of this can be taken for the emotional record.

		Date and mark Oct. 25	Date and mark Nov. 23	Date and mark Dec. 23
Attitude towards difficulties	avoidance	+		
	protest			
	making of effort		+	+

These matters are given the index figure (2). The list is so arranged that progress is shown by the increase of + at the end of the list.

There is a third group of items that should tend to disappear with healthy development. When present they should be marked +. Progress is shown by the

disappearance of the + sign. They are given the index mark (3). For example:

	Date and mark Oct. 25	Date and mark Nov. 23	Date and mark Dec. 21
Feeding difficulties	+	+	

Certain items classified as intellectual activity gradually become constant. When established they should be marked +. Progress is shown by the succession of + marks. These items are given the index mark (4).

I

GENERAL

Name of child
Date of Birth
Sex
Place in Family
Home Conditions
Date of entry to school.

HEALTH RECORD

If age of teething normal
If age of walking normal
Illnesses in infancy
Present health and nutrition
Any physical peculiarities or defects.

II

	Dates and Marks	Progress recorded
PHYSIOLOGICAL FUNCTIONING		
(1) Bladder control ..		
(1) Bowel control ..		
(3) Constipation ..		
(3) Feeding difficulties ..		
(3) Sleeping difficulties ..		
(3) Listlessness		
(3) Specific Symptoms ..		
e.g. Catarrhal condition		
Asthma, etc ..		
etc.		
etc.		
MUSCULAR CONTROL AND BALANCE		
(1) Walking		
(1) Running		
(1) Skipping		
(1) Hopping		
(1) Climbing		
(1) Balancing		
etc.		
etc.		
SKILL AND CO-ORDINATION		
(1) Turning taps		
(1) Use of spoon		
(1) Opening doors ..		
(1) Putting on shoes ..		
(1) Putting on coat or overall		
etc.		
etc.		
etc.		

III

Intellectual Activity	Particular material or situation	Dates and Marks	Progress recorded
(4) Experiments with raw or crude material			
(4) Experiments with Suggestive material, objects in the environment or new situations			
(4) Ability to express an idea in play; to carry out a self-made plan; to make recognizable things, i.e., the beginning of work			
(4) Sustained attention and increasing effort			
(4) Memory of previous experiences			
(4) Increasing use of language; length of sentence; sustaining conversation			
(4) Learning with interest e.g., use of didactic apparatus for numbers, reading, etc.			
etc.			
etc.			
etc.			

IV

EMOTIONAL BEHAVIOUR		Dates and Marks	Progress recorded
(2) General Mood	Depressed Confident		
(2) General Behaviour	Dreamy Alert		
(2) Response to Difficulties—i.e., intellectual problems, frustration, accidents	Avoidance Protest Making effort		
(2) Relative amount of imaginative play	Preponderance or absence : Interspersed with reality play having intellectual interest		
(2) Specific Symptoms	Thumb sucking Stammering Failure to talk Enuresis etc. etc. etc.		

V

Social Behaviour	Dates and Marks	Progress recorded
(2) *Social behaviour with Adults* ..		
Aloofness—avoidance or shyness		
Dependence		
Defiance or hostility		
Response to suggestions or requests		
Making spontaneous offers of help etc.		
etc.		
(2) *Social behaviour with Children* ..		
Plays alone		
Makes tentative approach or imitates others		
Plays as an individual near others		
Responds to advances of others		
Makes advances with a co-operative spirit		
Has a special friend(s) ..		

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